5,000 January 15, 1915

SECOND

Biennial Crop Pest and Horticultural Report

1913-1914

Oregon Agricultural College
Experiment Station
Corvallis, Oregon

The bulletins and publications of this station are sent free to all residents of Oregon who request them

STATION STAFF

Board of Regents of the Oregon Agricultural College and Experiment Station

Hon. J. K. Weatherford, President	Albany
Hon. E. E. Wilson, Secretary	Corvallis
Hon. B. F. Irvine, Treasurer	Portland
Hon. Oswald West, Governor of the State	Salem
Hon. J. A. Churchill, State Superintendent of Public Instruction	Salem
Hon. Ben W. Olcott, Secretary of State	Salem
Hon. Charles E. Spence, Master of State Grange	Canby
Mrs. Clara H. Waldo	Portland
Hon. Walter M. Pierce	La Grande
Hon. J. T. Apperson	Oregon City
Hon. C. L. Hawley	McCoy
Hon. H. Von Der Hellen	Wellen
Hon. G. M. Cornwall	Portland

Administration

W. J. Kerr, D. Sc.	President
A. B. Cordley, M. S.	Director
R. M. Rutledge, B. S.	Secretary

Department of Agronomy

H. D. Scudder, B. S.	Agronomist
G. R. Hyslop, B. S.	Associate Crops
W. L. Powers, M. S.	Assistant Irrigation and Drainage
C. V. Ruzek, B. S.	Assistant Soils
J. E. Cooter, B. S.	Assistant Soils Laboratory

Department of Animal Husbandry

E. L. Potter, B. S.	Animal Husbandman
G. R. Samson, B. S., A. B.	Assistant Animal Husbandman
O. M. Nelson, B. S. A.	Assistant Animal Husbandman
C. E. Robinson	Foreman College Stock Farm

Department of Bacteriology

T. D. Beckwith, M. S.	Bacteriologist
A. F. Vass, M. S.	Assistant Soil Bacteriology

Department of Botany and Plant Pathology

H. S. Jackson, A. B.	Botanist and Plant Pathologist
H. P. Barss, M. S.	Assistant Research
F. D. Bailey, A. B.	Assistant Crop Pest Investigation
J. R. Winston, M. S.	Plant Pathologist, Hood River

Department of Dairy Husbandry

Roy R. Graves, M. S.	Dairy Husbandman
Otto G. Simpson, B. S.	Assistant Dairy Manufacturing
E. R. Stockwell, B. S.	Assistant

Department of Chemistry

H. V. Tartar, B. S.	Chemist
Bert Pilkington, B. S.	Assistant Research
R. F. Beard, B. S.	Assistant Chemist
R. H. Robinson, M. S.	Assistant Chemist

Department of Entomology

H. F. Wilson, M. S.	Entomologist
A. L. Lovett, B. S.	Assistant Crop Pest Investigation
Le Roy Childs, A. B.	Assistant Research
G. F. Moznette, B. S.	Assistant Crop Pest Investigation

Division of Horticulture

C. I. Lewis, M. S. A.	Vice-Director and Horticulturist
V. R. Gardner, M. S.	Associate Pomology
E. J. Kraus, B. S.	Associate Research
A. G. B. Bouquet, B. S.	Assistant Olericulturist
F. R. Brown, B. S.	Assistant Crop Pest Investigation
G. S. Ralston, B. S.	Assistant Research
A. F. Barss, M. S.	Assistant Research
J. R. Magness, B. S.	Assistant Research
C. C. Starring, B. S.	Assistant Hood River Horticulturist
G. L. Philp, B. S.	Orchard Foreman

Department of Poultry Husbandry

James Dryden	Poultry Husbandman
Clara Nixon, B. S.	Research Fellow
C. S. Brewster, B. S.	Foreman Poultry Plant

Department of Veterinary Medicine

B. T. Simms, D. V. M.	Veterinarian

Robert Withycombe, B. S.	Supt. Eastern Oregon Substation, Union
D. E. Stephens, B. S.	Supt. Eastern Oregon Dry-Farm Substation, Moro
L. R. Breithaupt, B. S.	Superintendent Harney Substation, Burns
F. C. Reimer, M. S.	Superintendent Southern Oregon Substation, Talent
R. W. Allen, M. S.	Superintendent Umatilla Substation, Hermiston

SECOND

Biennial Crop Pest and Horticultural Report

1913-1914

Oregon Agricultural College
Experiment Station

Corvallis, Oregon

January 4, 1915.

To the President of the College.

Sir:

I hereby submit for publication the Second Biennial Crop Pest and Horticultural Report as required by law (see Chapter 144, Session Laws, 1911).

This law was enacted at the urgent solicitation of prominent horticulturists throughout the State and this report together with the preceding one, unquestionably indicate the value of the work.

Respectfully,

A. B. Cordley,

Director.

CONTENTS.

PART I.

Page.

Report of the Division of Horticulture 5
Preface 6
Fertilizer Tests on Onion Lands 7
Greenhouse Tomato Investigations 25
Fruit-Pit Studies in the Willamette Valley 35
The Pear as Affected by Moisture Supply 38
Strawberry Varieties in Oregon 50

PART II.

Report of the Department of Entomology 95
Introduction 95
The Fruit Tree Leaf Syneta 96
The Bud Moth 102
The Fruit Tree Leaf Roller 109
The Peach and Twig Borer 113
An Apple Leaf Miner 119
A New Cherry Pest 121
Injurious Gall Mites 123
Insect Pests of Stored Products 127
The Thistle Butterfly 131
Grasshoppers in Oregon 133
Insecticide Investigations of 1914 137
The Variegated Cutworm 141
The Rose Curculio Injures Blackberry Buds 150
The Radish Weevil, a New Pest 154
Clover Seed Injured by Midge 157
Nematode Gallworms or Eelworms 159
Tipulid Work in Prune Wood 166
The Tomato Worms 170
The Antique or Rusty Tussock Moth 173
The Brown Lacewing 181
The Alfalfa Looper as a Truck Crop Pest 184
The Rose-Leaf Hopper as a Fruit Pest 189
Minor Insect Pests 195

PART III.

Report of the Department of Botany and Plant Pathology 203
Introduction 203
A Pacific Coast Rust Attacking Pear, Quince, etc 204
A New Filbert Disease in Oregon 213
Bacterial Gummosis or Bacterial Canker of Cherries 224
Experimental Spraying of Prunes for Control of Brown Rot 241
Notes on Miscellaneous Potato Diseases 245
Potato Spraying Experiments 257
Notes, Observations and Minor Investigations of Plant Diseases 261

PART I.

Report

OF THE

Division of Horticulture

PREFACE.

The report of the Division of Horticulture contains five chapters, including the subject—Fertilizer Tests of Onion Land, Greenhouse Tomato Investigations, Fruit Pit Studies in the Willamette Valley, The Pear as Affected by Moisture Supply, and Strawberry Varieties in Oregon. These are mostly in the nature of preliminary reports. We are continuing the investigations and hope to publish our complete findings at a later date.

In addition to these reports, we have issued one bulletin on Loganberry By-products during the past year under the Crop Pest and Horticultural Fund.

We are also working on many other problems of interest to the horticulturists of the State. We are continuing our work with Loganberries, and have worked two years on the evaporation of the prune in attempting to determine what standardization can be effected, and while progress has been made on this work, we are not ready for publication of our findings at this time. We are conducting experiments—in the use of shade crops, cover crops, manures; extensive investigations on pruning the apple; plant breeding investigations with the apple, pear, cherry, prune and strawberry; Loganberry investigations along the line of culture, training, pruning, use of fertilizer; vegetable gardening investigations, including forcing of vegetables under glass, growing of winter vegetables, such as broccoli; and the breeding up of strains of vegetables for canning purposes. It may be several years before reports can be made on certain of these problems. We take the privilege at this time, however, of letting the growers know the nature of the problems upon which we are working.

C. I. L.

FERTILIZER TESTS ON ONION LANDS

By A. G. B. Bouquet.

The onion crop ranks as one of the most important of the commercial vegetables produced in Oregon. In 1914 the estimated total number of acres controlled by the Confederated Onion Growers' Association of Oregon, alone, was about 570, with an output approximating 330 carloads. These figures do not include the estimates of quite a large acreage handled independently of the Association or the figures of the onion crop grown in various portions of the State for local and distant markets.

The Oregon onion has a well-deserved reputation for its solidity, desirable size and color, and good quality. Being a storage crop, it is especially valuable in that it can be suitably held according to existing conditions of supply and demand. It is marketed in all points of the Northwest, is shipped south to California, and has created a favorable impression in the past in Chicago and European markets.

As a whole, ruling prices for onions have been favorable to the growers for a number of years. Off years with ensuing low market prices have occasionally occurred, but this has been the exception rather than the rule. The prices of 1913, for instance, were extremely gratifying, while those of 1912 were exceptionally low.

The discussion in the following pages deals almost solely with the question of the fertilization of the lands in the Upper Willamette Valley, upon which the bulk of the commercial crop of Oregon onions is grown.

Objects of Experiments.

In 1912 requests came from certain growers in the vicinity of one of the onion-growing areas for assistance in planning cooperative fertilizer experiments by field tests for the purpose of ascertaining the actual value of various fertilizers under individual farm conditions.

When the project was taken up by the Experiment Station, in 1913, the work was started with the following objective points:

1. To ascertain by field tests the relative, economical efficiency of kinds and amounts of various onion fertilizers.

2. To study effect of particular fertilizers applied in certain amounts according to soil analyses.

3. To ascertain length of time the fertilizer applied is apparently effective.

4. To establish, if possible, estimates of conservative economical fertilizer applications adaptable to the conditions at hand.

5. To study factors in general affecting the yields of onions as influenced by commercial fertilizers.

For a number of years the majority of onion-growers have been following a line of general fertilization of onion land without making actual field tests as to the relative efficiency of any one fertilizer or varying amounts of that particular fertilizer, with a view to determine the actual cost of the material and its application.

For the purpose of carrying out the tests discussed in the following pages, cooperation has been effected between the Experiment Station and several growers, among whom are C. L. Leedy, S. Weckert, R. W. Rasmussen, M. Conselmann, and A. Campbell, of Sherwood, Oregon. To these men the writer wishes to express his thanks for their hearty cooperation in the field work, and also for personal kindnesses rendered. Valuable assistance has been given by Professor H. V. Tartar of the department of Agricultural Chemistry, in making soil analyses and in tendering suggestions. Acknowledgement is herein also given to students W. H. Dunham, and E. and H. Pearcy for helpful field assistance.

Beaverdam Soils.

The soils upon which the application of fertilizers was made are the true beaverdam soils of Washington County. Concerning these, C. E. Bradley, in "A Chemical Study of Some Oregon Beaverdam Soils," 1905, says: "The beaverdam soils, when virgin, are composed largely of organic material of a peaty nature. The decomposition of leaves, twigs, and fine debris gives rise to one grade, the decay of larger bodies of wood another, while these soils are still further modified by clay washings from surrounding slopes. The term 'beaverdam' is applied to these lands from the fact that beavers were instrumental in forming these swamps by damming the streams which drain them. The vegetation common to these soils is reed grass, willow, Spanish needle, hardhack, cat tails, wild parsnip, etc. The greater portion of these areas overflows in the wet season.

"These soils are black when moist, changing to a gray when dry. They are porous, light and loose, with no tendency to bake or form lumps. Their characteristic sponginess, on account of their large organic content, is shown by a quaking of the earth when loads are driven over them; they burn readily when dry, and in consequence of this fact great damage in these soils is wrought by fire. A curious feature is their ability to shed water, due to a resinous content which may be extracted with ether. There is no subsoil except at considerable depths.

"The nitrogen content of these soils is large; some application is made of them as nitrogenous fertilizers for clay lands."

Since the time that the above description was written, these lands have been passing through gradual changes, being closely and heavily cropped, and varying year by year in physical and chemical characteristics. In some instances cropping for fifty years or more is beginning to reveal physical and chemical defects of the soil. The organic matter content in some areas, depleted year after year by constant cropping, is disappearing quite rapidly. Layers of soil other than the original beaverdam can be turned up to the surface, showing the hard usage of the soils in producing enormous quantities of onions in past years.

Drainage of these lands is always attended with more or less difficulty, due to their heaving and constant changing; yet satisfactory outlets are most essential for uniform yields of good plant growth and proper-sized bulbs.

Selection of Soils for Field Tests.

As much attention as possible was paid to locating all experimental work on soil that was typical of the general soil of the farm. Care was taken also in selecting soil that showed uniformity of elevation, good drainage, uniformity of previous fertilization, and uniformity of physical characteristics. While there was variation that was noticeable as the work proceeded, yet mention is made of these conditions and due account made for the variation in resulting yields or sizes of onions.

As will be noticed from the analyses of the soils from the various farms, the contents of nitrogen, phosphoric acid, and potash differed relatively, while the variation in elevation was but slight except in particular cases mentioned.

Farm Number 1.

Except for a collapsed drain on part of the experimental plots, the soil selected for field tests was of ordinary beaverdam character, uniform in elevation, and showing by analysis high plant-food contents, except phosphorus. The previous fertilization on these plots has not been extremely heavy, manure having been used at intervals, and, in addition, an average yearly application of 450 lbs of commercial fertilizer an acre.

In 1913 blight made its appearance, due to late spring and early summer rains, but it was not bad enough to cause a material change in any individual plot.

The land for 1914 tests was situated at the other end of the farm, and was typical of that portion of the beaverdam.

Both of these pieces had been continuously cropped with onions for nine years, and the yield had been approximating 200 to 240 sacks.

Fig. 1. Fertilizer plots on Farm No. 1; Onions curing.

Farm Number 2.

Field tests were carried out on soil on about the center of Mr. Rasmussen's stretch of beaverdam. This land was uniform in elevation and was apparently free from any undue influences of bad drainage. The amount of organic matter was high, and the soil by analysis showed high potash and medium high phosphorus content.

This land had not been cropped with onions for one year, having been summer fallowed for the purpose of getting rid of morning-glory. No manure was applied in 1914.

Farm Number 3.

This soil, lying on a level with the above-mentioned land, has been cropped with onions for upwards of fifteen years, during which time it has been consistently fertilized with manure and commercial fertilizer. This land is a good grade of beaverdam, and is thoroughly drained.

Liberal applications of commercial fertilizer have been made on this farm

Fig. 2. Experiments on Farm No. 2; pulling onions September 7th.

an average of 8,500 lbs. of phosphoric acid fertilizer and 2,000 lbs of muriate of potash being used on eight acres, yearly.

The soil used in 1914 was very similar to that in use in 1913. Late rains caused two plots in the latter year to be decreased, owing to excess of water on the ground.

No manure was used on the experimental plots in either year.

Farm Number 4.

The condition of the soil used in field tests was both physically and chemically excellent. This land had been also consistently fertilized with fairly heavy applications of superphosphate and muriate.

With the exception of Plot 6, on which water stood for a short time, the drainage was excellent.

The comparative stand and growth of the several plots in 1913 was very uniform. There was some blight caused by late rains, but the bulbs seemed to be unaffected.

No experimental plots were used on this farm in 1914.

Farm Number 5.

The experimental plots on this farm consisted of soil that varied considerably from the type of beaverdam on the other farms. The organic content was low and the soil was perceptibly heavier, more cloddy, and had the appearance in places of a soil more nearly resembling a good clay loam rather than beaverdam. Analysis showed a high potash content, but rather low phosphorus, and still lower nitrogen content compared with other samples.

The stand of onions in 1914 was comparatively small, as is shown by the illustrations in Figure 4.

There seemed to be a variation in the fertility of the land in all of the plots, an imaginary line running lengthwise of the plots showing a heavier yield of bulbs at the north ends compared with that of the south ends.

In all plots the onions were small. The bulbs were topped in the field, inasmuch as they were grown under contract for shipment South for seed purposes.

Manure was applied to the plots in the fall immediately after the previous crop had been harvested.

Experimental Plots.

The size of all plots in field tests was 20 feet by 50 feet, 1,000 square feet, approximately one forty-third of an acre. The number of plots on each farm varied from six to twelve, averaging ten. Between each plot was a two-foot walk, extending the length of each.

Check Plots.

But few onion growers make use of the check plot. In this experiment, however, every farm test had at least one check plot, and in some instances, two. These were chosen with a view to locating them on soil of uniform type and similar in physical and chemical characteristics, as far as possible, to the other plots.

Kinds and Prices of Fertilizers.

The fertilizers used in field work were as follows:

Nitrogen—Nitrate of Soda at $3.25 a cwt. $62.00 a ton.

Phosphoric Acid { Superphosphate at $1.40 a cwt. $26.00 a ton.
Bone Meal at $1.75 a cwt. $33.00 a ton.

Potash { Muriate of Potash at $3.25 a cwt. $55.00 a ton.
Sulphate of Potash at $3.60 a cwt. $63.00 a ton.

Special Onion Fertilizer No. 10, Portland Seed Company, Guaranteed Analysis, at $2.10 a cwt; $40.00 a ton.

- Nitrogen 3%
  Nitrate and Tankage.
- Phosphoric Acid 13% total—
  - 7.40% P_2O_5 Insol } Bone
  - 5.82% Avail } Tankage
  - 13.00% Total } Superphosphate
- Potash 12.70%—
  - 12% K_2O Sol. Sulfate
  - .70% Chlorine.

Lime—Ground limestone at 1c a lb.; $10.00 to $15.00 a ton.

New Mineral Fertilizer—Analysis. New England Fertilizer Company, at $1.25 a sack.

Potassium Oxide	1.56
Sodium	.63
Calcium Oxide	1.54
Magnesium Oxide	1.75
Iron	7.38
Sulfur	6.00
Silica	57.00
Chlorine	Trace
Alumina	7.53
Phosphoric Acid	.23

Formulas—Fertilizer Application.

The amounts of the various plant foods were proportioned according to the analyses of the soils and mixed accordingly.

The ingredients for the various field plots were correctly weighed, thoroughly mixed, and spread broadcast before final preparation of the soil. The majority of the fertilizer was harrowed in, while a small amount was plowed in. The average date of applying the fertilizer was March 28, the date varying with seasonal variations and difference in soil characters, location, drainage, etc.

Field Practices.

Onion seed in the beaverdam territory is usually dropped, by means of any reliable hand seeder, in rows thirteen to fourteen inches apart. The dates of sowing, which are entirely determined by particular seasonal conditions, vary from about the last of March to the 20th of April. Approximately from three and one-half to four and one-half pounds of seed is used an acre, and but little thinning is practiced amongst the majority of growers, except in cases of actual necessity. The Yellow Globe Danvers is the most widely grown variety for storage purposes, while some Red Globes are grown under contract to be shipped South for seed purposes.

The greater part of the onions grown on the experimental plots were pulled for field curing the first week in September. Weather conditions are of great importance in determining the date of this work. Hauling in to storage, with favorable weather conditions following pulling, usually takes place three weeks later, and September 25 to October 1 usually finds the majority of the crop in storage houses.

Onion Prices.

In the following tables discussing fertilizers and onion yields, the price of onions is held at $1.35 a hundred pounds. This seems to be a conservative estimate for the selling season, September to March, based on a ten-year average.

Field Observations.

Observations of the field plots were made regularly during the summer of each year, the dates of these averaging June 20 and July 24, respectively.

Particular attention was paid at these times to variations of plots as regards comparative stands of seedlings, growth and vigor of same, color of plants, presence of insect or disease pests, variations of soil conditions and effect of fertilizers.

Net Returns.

In the following tables and summaries, the net returns of each plot represent the gain or loss of the plot compared with the unfertilized plot, minus the cost of the fertilizer.

Table I. Tabulation of Results of Field Tests Showing Relative Efficiency of Fertilizers on Onions.

1913.

Farm Number 1.

Plot No.	Kind of fertilizer.	Formula.	Amount an acre (lbs.)	Cost an acre.	Gain or loss compared with check plot.		Net gain or loss an acre, inclusive of fertilizer cost.	
					Sacks untopped.	Lbs. untopped.	Sacks topped.	Onions valued at $1.35 a sack.
1	Superphosphate, muriate.	0.7.5.	500	$7.87	.....	(Note.) 35	15	12.38
2	Superphosphate	0.7.5.	1,000	15.74	.....	39	16	5.86
3	Special onion fertilizer No. 10.	.....	485	9.46	.....	—3	— 1	—10.81
4	Check plot	.....	.....	.....	.....	.....	.....	.....
5	Lime, superphosphate, muriate.	.....	Lime 430, Superphosphate 400, Muriate 100.	12.04	.....	38	16¼	10.01
6	Lime	.....	650	4.87	.....	— 1	— ½	— 5.45
7	New mineral fertilizer.	.....	1,075	12.25	.....	— 4	— 1¾	—14.61
8	Lime, bone meal	.....	Lime 650, bone 786.	18.00	.....	—25	—10¾	—32.50
9	Superphosphate	.....	400	5.00	.....	32	13	12.55
10	Superphosphate	.....	1,200	15.00	.....	31	13	2.55
11	Lime, bone meal	.....	Lime 650, bone 343	10.87	.....	—48	—13¼	—38.73
12	Special onion fertilizer.	.....	970	18.92	.....	—105	—45	—79.67

NOTE.—(Onions topped.) Analysis of land used in above experimental plots was as follows: Nitrogen—1.46%, Phosphoric Acid—0.29%, Potash—1.32%, Lime—3.38%, Magnesia—0.72%, Acidity—525 lbs. limestone per acre foot.

Summary.

An examination of Table I shows that gains were obtained only from the use of superphosphate and muriate of potash. The gains with superphosphate alone were not quite so great as when it was used with the muriate.

The increased expenditure for fertilizer in Plots 2, 5 and 10 make the net gains less than those obtained by using smaller amounts of the fertilizer. The gross yield of the Plots 1, 2, 5, 9 and 10 is very similar, as will be noticed. In every instance but one, the smaller amount of superphosphate for each acre gives a slightly larger yield than a larger amount, and the net gains were therefore increased.

No plots were fertilized with potash alone. Those receiving both superphosphate and potash gave large gross gains over those having only superphos-

phate, but these gains were not sufficiently large to cover the extra cost of the muriate, and there was an ensuing net loss. The soil on this farm showed low phosphoric acid and high potash content.

Both the special onion fertilizer and the new mineral fertilizer failed to show gross gains, in each case producing approximately the same amount as the check plot. The low yield of Plot XII was apparently due to poor drainage. Both of the above fertilizers named were complete fertilizers.

The use of lime alone gave the same yield as the check plot, and in combination with bone meal gave inferior yields.

The yields as a whole on this farm were medium to good. The net gains as a result of the fertilization, however, were comparatively small.

Table II. Summary of Results Showing Relative Efficiency of Various Fertilizers on Onions.

1914.

Farm Number 2.

Plot No.	Kind of fertilizer.	Formula.	Amount an acre (lbs.)	Cost an acre.	Gain or loss compared with check plot.		Net gain or loss an acre, inclusive of fertilizer cost.	
					Sacks untopped.	Lbs. untopped.	Sacks topped.	Onions valued at $1.35 a sack.
1	Superphosphate...	0.6.0.	400.....	$5.00	3⅓	260	75	96.25
2	Superphosphate...	0.6.0.	800.....	10.00	4	292	83	102.05
3	Superphosphate...	0.6.0.	1,200.....	15.00	3½	273	75	86.25
4	Check plot.....	.....	.....	.....	.....	.....	.....	.....
5	Superphosphate, Muriate of potash	0.6.8.	550.....	9.46	2	166	47	54.00
6	Superphosphate...	.....	989.....	12.36	1	96	27	24.09
7	Check plot.....	.....	.....	.....	.....	.....	.....	.....
8	Lime.....	.....	430.....	3.22	.....	13	— 3½	— 7.94
9	Superphosphate, muriate.	0.6.8.	1,100.....	18.92	2½	271	77	85.03
10	Muriate of potash.	0.0.8.	313.....	9.40	.....	64	18	14.90

Analysis of soil used in experimental work above:
Nitrogen—1.42%, Phosphoric Acid—0.23%, Potash—0.84%, Lime—1.15%, Magnesia—0.21%, Acidity slight.

Summary.

In comparing yields of various plots with the check plots in Table II the mean of the two check plots was taken.

The results in Table II show decided gross and net gains through the use of superphosphate. It will be noticed that the extra gains through the use of double and triple the amount of Plot I are indifferent; in one case, namely, in the triple application, showing a net loss of $6.00 compared with Plot I.

Muriate of potash without superphosphate gave a slight net gain, but combined with the latter gave the third largest gross yield, and in Plot V showing a decided increase.

Lime, alone, gave a yield inferior to the mean of the two check plots. The acidity in this soil was slight, the phosphoric acid low, and the potash medium high.

Of the farms used in the experimental work, the plots above showed the greatest response to the various materials used.

Fig. 3. The heaviest yielding plot on Farm No. 2; superphosphate at the rate of 800 lbs to the acre being applied.

Table III. Summary of Results Showing Relative Efficiency of Various Fertilizers on Onions.

1913.

Farm Number 3.

Plot No.	Kind of fertilizer.	Formula	Amount an acre	Cost an acre	Gain or loss compared with check plot.		Net gain or loss an acre, inclusive of fertilizer cost.	
					Sacks untopped.	Lbs. untopped.	Sacks topped.	Onions valued at $1.35 a sack.
1	Superphosphate, muriate of potash.	0.4.8	390	$7.61	.....	41	11¼	$8.25
2	Superphosphate, muriate of potash.	0.4.8	780	15.22	.....	21	6	— 7.12
3	Superphosphate, muriate of potash.	0.4.8	1,170	22.83	.....	—97	—27¾	—60.29
4	Check plot	.....	.....	.....	.....	.....	.....	.....
5	Special onion fertilizer No. 10.	(*)	485	9.46	.....	— 4	— 1¼	—11.82
6	Lime, superphosphate, muriate.	0.4.8	Lime 650, superphosphate 233, muriate 150.	12.30	½	38	10¾	2.21
7	Lime	.....	650	4.87	—1½	—80	23	—35.92
8	Lime, superphosphate, muriate.	0.4.8	Lime 650, superphosphate 466, muriate 300.	21.67	.....	—87	27¾	—51.64
9	Lime, bone meal, muriate.	0.4.8	Lime 650, bone 400, muriate 300.	22.79	.....	—54	15½	—35.69
10	Muriate	.....	245	7.31	.....	—260	—74	—99.90
11	Special onion fertilizer No. 10.	.....	970	18.90	.....	—326	—93	—125.55
12	New mineral fertilizer.	.....	1,075	12.25	.....	—43	—12	—28.45

(*) 3% Ntrogen, 7.4% available Phosphoric Acid, 12% Potash.

Analysis of soil on above experimental plots was as follows:

Nitrogen—1.15, Phosphoric Acid—0.62, Potash—0.67, Lime—2.43, Magnesia—0.57, Acidity—543 lbs. limestone an acre foot.

1914.

Plot No.	Kind of fertilizer.	Formula.	Amount an acre (lbs.)	Cost an acre.	Gain or loss compared with check plot.		Net gain or loss an acre, inclusive of fertilizer cost.	
					Sacks untopped.	Lbs. untopped.	Sacks topped.	Onions valued at $1.35 a sack.
1	Superphosphate, muriate.	0.7.8.	645	$8.32	.....	28	8	.48
2	Superphosphate	.....	700	8.75	.....	36	10	4.75
3	Superphosphate	.....	1,030	12.90	.....	21	6	— 4.80
4	Check plot	.....	.....	.....	.....	.....	.....	.....
5	Muriate	.....	313	9.40	.....	47	13	8.15
6	Superphosphate	0.7.8.	1,345	22.30	.....	56	16	— .70

Analysis of soil on above experimental plots was as follows:

Nitrogen—1.38%, Phosphoric Acid—0.44%, Potash—1.15%, Lime—1.78%, Magnesia—0.52%, Acidity slight.

Summary, 1913.

The net results obtained from the various fertilizer plots show a uniform loss almost throughout the entire list.

With the exception of one or two plots, which were unfavorably situated, the land as a whole was uniform in character and analyzed high phosphoric acid and medium high potash contents.

The plots showing gross increase in yield over the check plot were: No.1 with the smallest amount of superphosphate and muriate; 6 with lime and the amount of fertilizer in Plot 1; and 2 with twice as much fertilizer as used in Plot 1. Of these three, Plots 1 and 6 gave slight net returns.

It is significant to note that in Plot 3, with three times the amount of Plot 1, no gain in yield occurred.

The inferior yields in Plots 10 and 11 were due to late spring rains, a slight depression in the ground, and drainage inferior to the surrounding plots. The onions were smaller and the plots showed the inefficiency of fertilizers applied on land having physical drawbacks.

The special onion fertilizer and the new mineral fertilizer failed to show any gain, although both are complete fertilizers.

The very favorable yield obtained on the check plot shows natural fertility in this land. The yield on all plots was excellent, excepting Nos. 10 and 11.

Lime alone showed a decided loss. The soil by analysis showed slight acidity.

Expensive applications of commercial fertilizer show a decided net loss on this land.

Table IV. Summary of Results of Field Tests Showing Relative Efficiency of Various Fertilizers on Onions.

1913.

Farm Number 4.

Plot No.	Kind of fertilizer.	Formula.	Amount an acre	Cost an acre.	Gain or loss compared with check plot.		Net gain or loss an acre, inclusive of fertilizer cost.	
					Sacks untopped.	Lbs. untopped.	Sacks topped.	Onions valued at $1.35 a sack.
1	Superphosphate, muriate.	0.7.5.	500	$7.87	1	.....	28	29.93
2	Superphosphate, muriate.	0.7.5.	1,000	15.74	½	.....	14	3.16
3	Superphosphate, muriate.	0.7.5.	1,500	23.61	- ½	.....	14	— 4.71
4	Check plot	.....	.....	.....	.....	.....	.....	.....
5	Lime	.....	1,075	5.37	½	.....	14	13.53
6	Lime	.....	2,500	12.50	—3	.....	82⅔	—128.60
7	Lime, superphosphate, muriate.	.....	Lime 2,500, superphosphate 400, muriate 100.	20.79	—2	.....	—57	— 88.19
8	New mineral fertilizer.	.....	1,075	12.25	—1	.....	—28	— 50.05
9	Lime, superphosphate, muriate.	.....	Lime 2,500, superphosphate 800, muriate 200.	31.08	— ½	.....	—14	— 50.00
10	Nitrate of soda, superphosphate, muriate.	2.7.5.	Nitrate 250, superphosphate, 800, muriate 200.	33.65	1	.....	28	4.15

Analysis of land of above experimental plots is as follows:
Nitrogen—1.38%, Phosphoric Acid—0.34%, Potash—1.36%, Lime—2.43%, Magnesia—0.76%, Acidity—2,275 lbs. limestone an acre-foot.

Summary, 1914.

The soil on this farm has been consistently and heavily fertilized for a number of years preceding its use for fertilizer tests.

The variation in yields on the six experimental plots was slight, and but little net profit was obtained. The yields of these plots, as in the year 1913, were excellent, the stand of onions being very good and the size medium large to large. Gains over the check plot were obtained through the use of superphosphate and muriate. Double the amount of these two fertilizers in Plot 6 gave a very slight increase over the same fertilizers in Plot 1, with an ensuing loss of seventy cents.

A smaller amount of superphosphate in Plot 2 gave an increased gross and net yield over a larger amount in Plot 3. Gains with muriate of potash alone were slight.

The analysis of this soil showed medium high phosphoric acid and high potash contents.

Fertilization on these plots shows, as a whole, a decided net loss. The low cost of the small amount of the fertilizer is responsible for a gain of approximating $30.00, a larger amount of the same combination of fertilizers showing practically no gain.

The low yield in Plot 6 seems to be more or less directly traceable to water that stood on this plot, as shown by the cracking of the ground under influence of hot weather later.

Part of Plot 7 seems also to be affected by this late water and the yield is correspondingly decreased.

New mineral fertilizer yielded less than the check plot.

A complete fertilizer in Plot 10 showed a gain of one sack for the plot, but the fertilizer was expensive.

Increased applications of superphosphate and muriate give lessened net yields compared with the amount used in Plot I.

The land used for experimental work has been consistently fertilized for a number of years with manure and commercial fertilizers.

Table V. Summary of Results of Field Tests Showing Relative Efficiency of Various Fertilizers on Onions.

1914.

Farm Number 5.

Plot No.	Kind of fertilizer.	Formula.	Amount an acre (lbs.)	Cost an acre.	Gain or loss compared with check plot.		Net gain or loss an acre, inclusive of fertilizer cost.	
					Sacks untopped.	Lbs. untopped.	Sacks topped.	Onions valued at $1.35 a sack.
1	Superphosphate, sulfate.	0.8.8.	600	$10.50	1¼	.....	53¾	72.56
2	Superphosphate, sulfate.	0.8.8.	1,200	21.00	2½	.....	96¾	130.61
3	Superphosphate, sulfate.	0.8.8.	1,800	31.50	1¾	.....	75	82.33
4	Check plot	.....	.....	.....	.....	.....	.....	.....
5	Superphosphate	.....	930	11.62	— ½	.....	—10	—25.12
6	Special onion fertilizer.	.....	485	9.46	1	.....	43	48.59
7	Superphosphate	.....	650	8.12	1	.....	43	50.00
8	Check plot	.....	.....	.....	.....	.....	.....	.....
9	Lime	.....	860	6.45	— ½	.....	—10	—20.95
10	Sulfate	.....	313	9.40	0	.....	0	9.40

Analysis of soil of above experimental plots as follows:
Nitrogen—0.58%, Phosphoric Acid—0.31%, Potash—0.96%, Lime—1.71%, Magnesia—0.19%
Acidity—very slight.

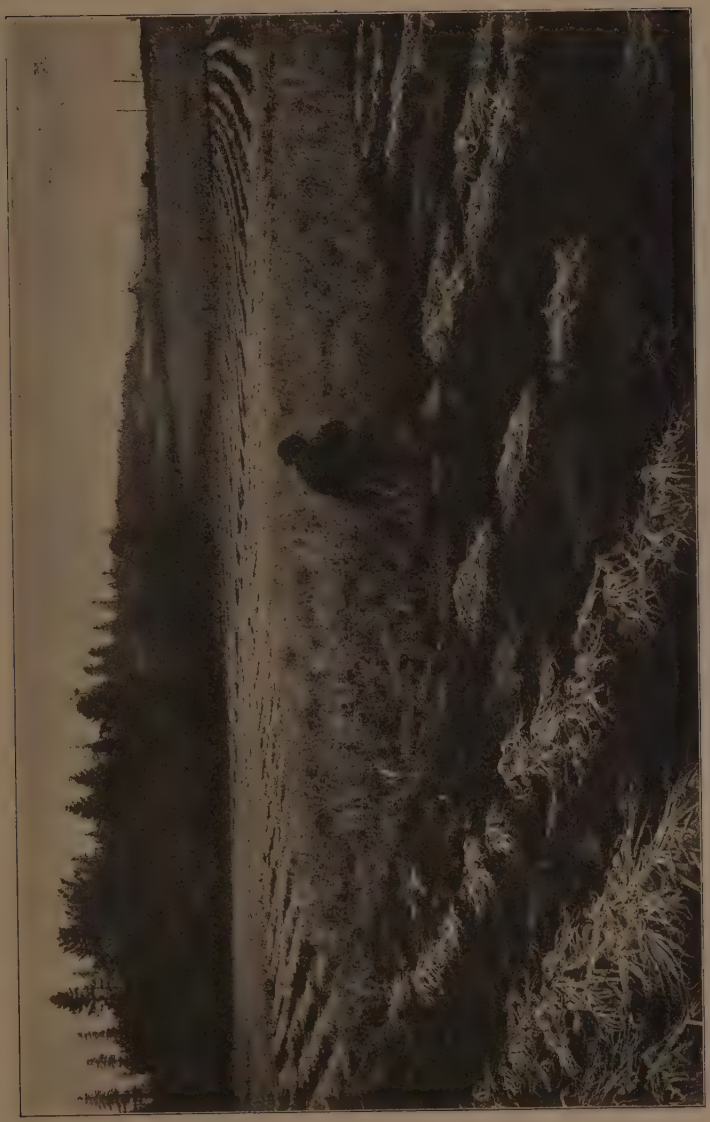


Fig. 4. Poorly drained area on Farm No. 5. Note small onion growth in center and inferior yield of bulbs in foreground.

Summary.

The onions on plots tabulated in Table V were undersised and the yields were poor. The stand in almost all of the plots was inferior. The character of the soil was not favorable for heavy yields of large onions.

Organic matter in this soil was largely lacking compared with that of average beaverdam. Other characteristics of this soil are discussed in previous pages.

The highest gross and net yield was obtained through a medium heavy application of a combination of superphosphate and muriate. As will be noticed, the above combination, in all three cases, was effective.

The two check plots produced a like amount. Special onion fertilizer, No. 10 complete, showed a gain of one full sack. Lime gave no increase, and it is difficult to account for the variability in yields of Plots 5 and 7, in which superphosphate was used alone.

The physical condition of this land made variations in yields, due to fertilizers, quite unlikely.

Table VI. Onion Fertilizer Tests.

Low yields of onions traceable to poor physical condition of soil.

Farm number.	No. of plot.	Fertilizer used and amount for each plot, lbs.	Yield compared with check plot sacks untopped.	Loss, Onions at $1.35 a sack.	Remarks.
4	6	Lime..... 60	— 3	—128.60	Water standing in June, soil later cracked.
1	8	Lime..... 15 Bone..... 18	— 25	— 27.66	Collapsed drain.
3	10	Muriate..... 5½	—260	— 99.90	Late spring and early summer, rains affected Nos. 10 and 11.
3	11	Special onion fertilizer... 22½	—326	—125.55	Late spring and early summer. rains affected Nos. 10 and 11.

Table VII. Field Tests Showing Efficiency of Phosphoric Acid Fertilizers (Alone) on Onion Lands, Washington County, Oregon, 1913 and 1914.

Farm No.	Year	Plot No.	Kind of fertilizer used	Amt. an acre lbs.	Cost an acre	Gain or loss compared with check plot. Untopped. Sacks	Gain or loss compared with check plot. Untopped. Lbs.	Net gain or loss an acre inclusive of fertilizer cost. Sacks onions	Net gain or loss an acre inclusive of fertilizer cost. Onions valued $1.35 a sack	REMARKS.
2	1913	8	Bone	350	$ 6.02	—1–12	.....	—2 1–3	—10.69	Soil analysed low in phosphoric acid content.
2	1914	1	Superphosphate	400	5.00	3 1–3	260	75	96.25	Soil analysed low in phosphoric acid. Uniform soil conditions prevailed.
2	1914	2	Superphosphate	800	10.00	4	292	83	102.05	Little variation between yields of these three plots.
2	1914	3	Superphosphate	1200	15.00	3½	273	75	86.25	
1	1913	9	Superphosphate	400	5.00	.....	32*	13	12.55	Variation btween these two plots slight.
1	1913	10	Superphosphate	1200	15.00	.....	31*	13	2.55	Plot 10 having three times as much fertilizer as Plot 9, no increased yield resulting.
3	1914	2	Superphosphate	700	8.75	.....	36	10	4.75	Soil analysed medium to high in phosphoric acid.
3	1914	3	Superphosphate	1030	12.90	.....	21	6	—4.80	Soil previously heavily fertilized.
5	1914	5	Superphosphate	930	11.62	—¼*	.....	—10	—25.12	Land analysed low in nitrogen and phosphoric acid. Not good beaverdam.
5	1914	7	Superphosphate	650	8.12	1*	.....	43	50.00	

*Topped Onions.

Table VIII. Tabulation of Results of Field Tests Showing Relative Efficiency of Potash Fertilizers on Onion Lands, Washington County, Oregon, 1913 and 1914.

Farm No.	Year	Plot No.	Fertilizer used	Amt. an acre lbs.	Cost an acre	Gain or loss compared with check plot. Untopped. Sacks	Gain or loss compared with check plot. Untopped. Lbs.	Net gain or loss an acre inclusive of fertilizer cost. Sacks top'd onions	Net gain or loss an acre inclusive of fertilizer cost. Onions valued $1.35 a sack	REMARKS.
2	1914	10	Muriate of potash	313	$9.40	.....	64	18	14.90	Soil analysed medium high potash content.
3	1913	10	Muriate of potash	245	7.31	.....	—260	—74	—99.90	Late spring rains caused low yield on this plot.
3	1914	5	Muriate of potash	313	9.40	.....	47	13	8.15	Land analysed high potash content.
5	1914	10	Sulphate of potash	313	940	.....	None	None	—9.40	Soil showed medium high potash content.

Table IX. Field Tests Showing Efficiency of Phosphoric Acid Fertilizers Combined with Potash Fertilizers, Onion Lands, Washington County, Oregon, 1913 and 1914.

Farm No.	Year	Plot No.	Kinds of fertilizers used	Formula	Amt. lbs. an acre	Cost an acre $ c	Gain or loss compared with check plot.		Net gain or loss an acre inclusive of fertilizer cost		REMARKS.
							Sacks untopped	Lbs. untopped onions	Sacks topped onions	$ c	
2	1914	5	Superphosphate, muriate of potash..	0.7.5.8	550	9.46	2	166	47	†54.00	Land analysed low phosphoric acid content.
2	1914	9	Superphosphate, muriate of potash..	0.7.5.8	1100	18.92	2½	271	77	85.03	Land analysed low phosphoric acid content.
1	1913	1	Superphosphate, muriate of potash..	0.7.5	500	7.87	.....	35*	15	12.38	Land analysed high potash content.
1	1913	2	Superphosphate, muriate of potash..	0.7.5	1000	15.74	.....	39*	16	5.86	Land analysed high potash content.
4	1913	1	Superphosphate, muriate of potash..	0.7.5	500	7.87	1	.....	28	29.93	Land analysed high potash content.
4	1913	2	Superphosphate, muriate of potash..	0.7.5	1000	15.74	½	.....	14	3.16	Land analysed high potash content.
4	1913	3	Superphosphate, muriate of potash..	0.7.5	1500	23.61	½	.....	14	—4.71	Land analysed high potash content.
3	1913	1	Superphosphate, muriate of potash..	0.4.8	390	7.61	.....	41	11¾	8.25	Land analysed high phosphoric acid content.
3	1913	2	Superphosphate, muriate of potash..	0.4.8	780	15.22	.....	21	6	—7.12	Potash content medium high.
3	1913	3	Superphosphate, muriate of potash..	0.4.8	1170	22.83	.....	—97	—27¾	—60.29	Potash content medium high.
3	1914	1	Superphosphate, muriate of potash..	0.7.8	645	10.32	.....	28	8	.48	Land analysed low phosphoric acid content.
3	1914	6	Superphosphate, muriate of potash..	0.7.8	1345	22.30	.....	56	16	—.70	Land analysed low phosphoric acid content.
5	1914	1	Superphosphate, sulphate of potash.	0.8.8	600	10.50	1¼*	.....	53¾	72.56	Soil low in nitrogen and phosphoric acid.
5	1914	2	Superphosphate, sulphate of potash.	0.8.8	1200	21.00	2¼*	.....	96¾	130.61	Soil low in nitrogen and phosphoric acid.
5	1914	3		0.8.8	1800	31.50	1¾*	.....	75	82.33	Soil low in nitrogen and phosphoric acid.

*Topped Onions. †Onions valued at $1.35 a sack, 10 year average.

Table X. Tabulation of Results of Field Tests Showing Relative Efficiency of Miscellaneous Fertilizers on Onion Lands, Washington County, Oregon.

Farm No.	Year	Plot No.	Fertilizer used	Amount an acre	Cost an acre	Gain or loss compared with check plot		Net gain or loss an acre inclusive of fertilizer cost	
						Sacks untopped onions	Lbs. untopped onions	Sacks topped onions	Onions at $1.35 a sack $ c
2	1913	7 (Block 2)	Special Onion Fertilizer No. 10.	860	$17.20	—1	.....	—28	—55.00
1	1913	3	Special Onion Fertilizer No. 10.	485	9.46	.....	—3*	— 1	—10.81
1	1913	12	Special Onion Fertilizer No. 10.	970	18.92	.....	—105*	—45	—79.67
1	1913	7	New Mineral Fertilizer.....	1075	12.25	.....	—4*	— 1¾	—14.61
4	1913	8	New Mineral Fertilizer.....	1075	12.25	—1	.....	—28	—50.05
5	1914	6	Special Onion Fertilizer No. 10.	485	9.46	1*	.....	43	48.59
3	1913	5	Special Onion Fertilizer No. 10.	485	9.46	.....	—4	— 1¾	—11.82
3	1913	11	Special Onion Fertilizer No. 10.	970	18.92	.....	—326	—93	—125.55
3	1913	12	New Mineral Fertilizer.....	1075	12.25	.....	—43	—12	—28.45

*Topped Onions.

Table XI. Tabulation of Results of Field Tests Showing Relative Efficiency of Lime on Onion Lands, Washington County, Oregon, 1913 and 1914.

Farm No.	Year	Plot No.	Amount an acre. lbs.	Cost an acre. $ c	Gain or loss compared with check plot		Net gain or loss an acre inclusive of fertilizer cost		REMARKS.
					Sacks untopped onions.	Lbs. untopped. onions.	Sacks topped onions.	$ c	
2	1913	5 Block 1	2500	12.50	—5-12	.....	.....	†—28.62	Land analysed 2100 lbs. limestone an acre foot to correct acidity.
2	1913	2 Block 2	650	4.87	0	0	0	—4.87	Land analysed 1100 lbs. limestone an acre foot to correct acidity.
2	1914	8	430	3.22	.....	—13	—3½	—7.94	Acidity slight.
1	1913	6	650	4.87	.....	—1*	—½	—5.45	Land analysed 525 lbs. limestone an acre foot to correct acidity.
4	1913	5	1075	5.90	½	.....	.....	13.45	Analysis shows 2275 lbs. limestone an acre foot to correct acidity.
4	1913	6	2500	12.50	—3	.....	.....	—128.60	
3	1913	7	650	4.87	—1 1-3	—80	.....	—35.92	542 lbs. limestone an acre foot for acidity correction.
5	1914	9	860	6.45	—¼*	.....	.....	—20.95	Acidity slight.

*Topped Onions. †Onions valued at $1.35 a sack.

Table XII. Tabulation of Results of Field Tests Showing Relative Efficiency of Lime Combined with Plant Food Materials on Onion Lands, Washington County, Oregon, 1913 and 1914.

Farm No.	Year	Plot No.	Amount an acre lbs.	Cost an acre $ c	Gain or loss compared with check plot		Net gain or loss an acre inclusive of fertilizer cost	
					Untopped			
					Sacks	Lbs.	Sacks topped	Onions valued $1.35 a sack
2	1913	4	Lime 1250 Bone 375 Potash 150	17.00	½	.....	14	2.35
1	1913	5	Lime 430 Super 400 Muriate 100	11.25	½	38*	16¼	10.01
1	1913	8	Lime 650 Bone 786	18.00	.....	—25*	—10¾	—27.66
1	1913	11	Lime 650 Bone 343	10.87	.....	—48*	—13½	—38.73
4	1913	7	Lime 2500 Super 400 Muriate 100	20.50	—2	.....	—57	—88.19
4	1913	9	Lime 2500 Super 800 Muriate 200	28.50	—½	.....	—14	—50.00
3	1913	6	Lime 650 Super 233 Muriate 150	12.30	½	38	10¾	2.21
3	1913	9	Lime 650 Bone 400 Muriate 300	22.79	—5-6	—54	15½	—35.69

*Topped Onions.

General Summary.

1. Beaverdam lands, or lands of this character, vary greatly in their chemical analysis and in their actual working amount of fertility as set forth by field tests. Each farm is an individual problem and in few cases can a definite rule of general fertilization be economically applied to all.
2. Yields of onions are decreased by poorly drained areas, low spots, etc. Suitable outlets for excess water should be provided in order that the onions may reach standard size, and yield profitably.
3. All fertilization work should be checked up as far as possible by plots or similar areas unfertilized, and the work on these should be definitely and carefully planned.
4. Field tests only are able to demonstrate the efficiency of various fertilizers of unknown, or even known, chemical characteristics.
5. Simple field tests can easily be carried on by growers without much extra labor or money expended. These tests will throw as much light as possible on the question of economical soil fertilization.
6. If field tests are not conducted, it is possible to waste a good deal of money by the use of commercial fertilizers.
7. Expenditures for medium heavy to heavy applications of fertilizer are not always accompanied by resulting crop increase, and there is consequently a net loss.
8. It is advisable to study the characteristics and yields of onions on plots which have been fertilized a year previously, with a view of ascertaining the effect of the fertilizer in future crops.
9. Conservative estimates of the economical value of fertilizers on beaverdam land can only be determined by several years' actual field practice. The work up to the present time has covered but two seasons.

GREENHOUSE TOMATO INVESTIGATIONS.

By A. G. B. BOUQUET.

The work of investigating the economic value of forcing varieties, and problems of pollination relating thereto, was started in 1912, the report of the first part of the work being published in the Experiment Station Biennial Crop Pest and Horticultural Report of January, 1913.

Since that time two more crops of tomatoes have been grown in the Station greenhouses, and hence the following discussion treats of the results obtained from crops produced during the years 1912, 1913, and 1914.

The investigational work during that time was planned to cover, if possible, the following phases of tomato forcing under glass:

1. Tests of leading varieties to determine qualities of marketable value, such as earliness of maturity, uniformity in size, shape, and color, productivity, etc.
2. Studies of blossom clusters and blossoms of varieties with a view to determine, if possible, variation in regard to these characters and their economic value in producing fruit of marketable characteristics.
3. Tests with different methods of pollination to determine financial value to the grower.
4. Tests with methods of pollination for early fruit production.
5. Studies of varieties as to the percentage of the crop produced during each month of bearing.
6. Financial losses due to sterility of tomato blossoms.
7. Cooperative investigations in commercial greenhouses covering above features.

Cooperation was carried on in 1914 with F. B. Chase, of Eugene, Oregon, and will probably be continued in the spring of 1915 with Mr. Chase and other tomato growers.

Varieties.

The following varieties have been under observation during the years 1913 and 1914: Earliana, Jewel, Bonny Best, A-1, Comet, Stone, Globe, Adirondack Earliana, Best of All, Winter Beauty, Peerless.

In the tests of a variety, four plants are taken as the basis for computation, inasmuch as this number was recorded in the case of each variety.

Since several varieties produced ripe tomatoes on May 18 of one year and May 20 of another, the reckoning for a month's production of all varieties began from these respective dates.

Variety Records.

The fruits of four plants of each variety were recorded as to the date of ripening, cluster on plant, weight, and general character. In the case of testing different methods of pollination, four plants for each method were used. In 1913 two full greenhouses were devoted to these tests, the one house acting as a check upon the other.

Descriptions of individual varieties will be found in the following pages.

Methods of Pollination.

The pollination of blossoms was carried out as started in 1912. Blocks of plants were pollinated as quickly as possible by hand, using the tip end of the index finger. The work was carried on during the warmest part of the day. Records were kept of the blossoms on clusters of plants that were pollinated.

As often as any hand pollination was done, the plants that were to act as the first block of check plants were shaken, the third block being untouched.

The accompanying tables will reveal the results obtained in more detailed and more compact form than a long verbal discussion.

Tabulations.

Table No. I reviews the variation in yields of tomatoes for each month and total yields of different varieties, and that of different means of pollination of each variety, the record of four plants in each case being recorded. The total number of fruits produced through the season, as well as the average weight of the fruit, is also included.

Table I. Tests with Forcing Varieties of Tomatoes.

Variety.	Manner of pollination.	Amount produced first month of bearing.	Per cent of total amount.	Amount produced second month of bearing.	Per cent of total amount.	Amount produced third month of bearing.	Per cent of total amount.	Total amount produced.	No. of fruits produced.	Average weight of single fruits.
		ozs. 4 plts.		ozs. 4 plts.		ozs. 4 plts.		ozs. 4 plts.	4 plts.	ozs.
Bonny Best	Hand	198	31	272	42	168	26	638	102	6.0
Bonny Best	Jarring vines	216	22	445	46	289	30	950	142	6.6
Bonny Best	Check plants	130	20	333	52	168	26	631	146	4.3
Bonny Best	Hand	344	39	334	38	190	22	868	133	6.5
Comet	Hand	266	26	380	38	338	34	984	204	4.8
Comet	Jarring vines	182	28	271	41	197	30	650	149	4.3
Comet	Check plants	101	12	421	53	263	34	785	181	4.3
Comet	Jarring vines	239	24	382	39	354	36	975	200	4.8
Comet	Check plants	114	14	351	45	310	40	775	173	4.4
Earliana	Hand	325	39	188	22	319	37	832	172	4.8
Earliana	Jarring vines	268	41	238	36	146	22	652	130	5.0
Adirondack Earliana No. 2	Hand	215	21	436	43	340	34	992	180	5.6
Adirondack Earliana No. 2	Check plants	92½	12	302	41	338½	46	733	166	4.4
Adirondack Earliana No. 2	Jarring vines	128	17	427	59	168	23	723	144	5.0
Sutton's A 1	Jarring vines	267	32	297	35	264	32	828	174	4.7
Sutton's A 1	Check plants	152	23	273	42	217	34	642	135	4.7
Stone	Hand	223	25	452	51	210	23	885	121	7.3
Stone	Check plants	72	13	251	45	233	41	556	89	6.2
Stone	Jarring vines	163	20	338	43	286	36	787	132	6.9
Stone	Check plants	48	9	241	47	218	43	507	105	4.9
Stone	Hand	243	24	360	36	372	38	975	114	8.5
Stone	Jarring vines	142	19	375	51	215	29	732	112	6.5

A summarizing review of the above figures shows that:

1. On a basis of an average count deducted from the actual behavior of the above varieties in the greenhouse, 29% of the total tomato crop from plants of which three to five clusters had been hand pollinated, was produced in the first month of bearing. The amount of the whole crop produced during the second month of bearing was 38% from the same plants, and for the third month, 30%.

2. Those plants that were jarred or shaken, produced, during the first month of bearing, 25% of the total amount for the season; during the second month 43%, and during the third month 29%.

3. Those plants which were untouched, acting as check plants, produced 14% of the crop the first month, 46% the second month, and 37% the third month.

4. The total amount of fruit produced by those plants which received hand pollination during the first early blossoming was 401 lbs. 5 ozs., or an average of 14 lbs. 10 ozs. to the plant; by those plants which were jarred or shaken, 381 lbs.; by those plants unshaken, 289 lbs. 4 ozs.

5. By studying the figures of each variety separately in the above table it will be noticed that, except in one or two cases where the plants themselves

were somewhat inferior, the total yields of plants artificially pollinated were quite a good deal larger than those pollinated by jarring, while the plants so treated by the latter method were equally as superior to those plants acting as checks.

6. The average size of greenhouse tomatoes varies from 4 ozs. to 8½ ozs., the largest number of tomatoes falling between 5 and 6 ozs. The average size, however, varies considerably with individual varieties: Stone, for instance, in the above tables, produced many fruits that were above marketable size and valueless for packing in a fancy square basket.

Tables II and III give an account of the differences in varieties in their production of blossoms and fruit set during the first month of bearing, during which time best prices prevail. The average weight of fruits is important in its bearing upon market demands and basket-packing facilities.

Table II. Tabulation of Variety Records Showing Number of Blossoms Produced and Pollinated. Fruit Produced in One Month. 1913.

Variety.	Number of blossoms pollinated in first month, 4 plants.	Number of fruits set first month.	Total set at end of pollination May 3, 1913.	Ranking of varieties in blossom setting.		Amount of fruit produced first month, ozs.
				First month.	Total.	
Earliana	140	42	97	2	1	325
A 1	79	41	71	3	4	246
Bonny Best	110	53	92	1	2	344
Comet	90	39	77	4	3	266
Jewel	61	23	54	6	5	296½
Best of All	63	34	50	5	6	228
Stone	70	22	54	7	5	243½

Table III. Total Number of Fruits Per Four Plants Produced Through First Month of Bearing and Total Average Weight.

Variety.	Year.	Number of fruits produced.	Total amount of fruit.	Average weight of fruits.
Earliana	1912	70	428½	6.1
	1913	42	325	7.7
	1914	32	204	6.3
Jewel	1912	75	357	4.7
	1913	23	296½	12.8
	1914	43	378	8.8
Bonny Best	1912	68	360	5.3
	1913	53	346	6.5
	1914	49	325½	6.6
Globe	1914	31	264	8.5
A1	1912	41	246	6.0
	1913	36	229	6.3
Comet	1912	36	224	6.2
	1913	39	266	6.8
	1914	21	135	6.4

Table IV gives a detailed financial statement of the value of pollination methods as illustrated by various varieties.

The price of tomatoes is reckoned at 15c a lb. for the first month and 10c a lb. for the average of the season. The first estimate probably is conservative, for upwards of 20c and 25c a lb. has been received for many of the College crates of fancy stock unloaded in Portland. This price, then, can be modified in the tables to suit the individual grower and his conditions.

In figuring the increases of methods of pollination over the check plants, no reckoning has been made for the cost of hand pollination. This is a problem in itself, concerning which the Station has made some investigations, but no definite results are yet ready for publication.

Table IV. Comparative Financial Value of Pollination Methods.

1912.

Total number of ounces of fruit produced between May 25 and June 13, inc., one row of four plants.

Variety.	1 Hand pollinated ozs.	2 Jarring ozs.	3 Check ozs.	NOTE 1 over 2 ozs.	Increase of 1 over 3 ozs.	Increase of 2 over 3 ozs.	Financial Increase 1 over 2	Financial Increase 1 over 3	Financial Increase 2 over 3
Earliana	338	215	59	123	279	156	$1.15	$2.61	$1.46
Bonny Best	270	202	96½	68	173	105	.63	1.61	.98
Jewel	253	167	52	86	201	115	.80	1.88	1.07
Comet	103	95	53	8	50	42	.07	.46	.39

1913.

Amount produced from May 20 to June 20. Four plants of each variety.

Bonny Best	344	216	130	128	214	86	1.20	2.00	.80
Earliana	325	268	.....	57	.....	.....	.53	.....	.....
Adirondack Earliana	215	128	92	87	123	36	.81	1.15	.33
Comet	266	239	114	27	152	125	.25	1.50	1.17
A-1	.....	267	152	.....	.....	115	.....	.....	1.07
Stone	243	163	72	80	171	91	.75	1.60	.85

Statement of Comparative Financial Value of Pollination Methods of Tomato Varieties.

Total production a season. Four plants.

1913.

Variety.	1 Hand pollination	2 Jarring Vines	3 Check	Increase of 1 over 2	Increase of 1 over 3	Increase of 2 over 3
Bonny Best	$5.42	.....	$3.94	.....	$1.48	.....
Earliana	5.20	$4.07	.....	$1.13	.....	.....
Adirondack Earliana	6.29	.....	4.58	.....	1.62	.....
Comet	6.15	6.09	4.84	.06	1.31	$1.25
A-1	.....	5.17	4.01	.....	.....	1.16
Stone	5.53	4.91	3.16	.62	2.37	1.75
Jewel	4.68	3.68	3.18	1.00	1.50	.50

Table V deals with cooperative work with Mr. F. B. Chase, of Eugene, Oregon, in August, 1914, and also with computations made in the Station Greenhouses. The work of actual counting was carried out with an idea of ascertaining the approximate percentages of blossoms, relatively set and lost under average greenhouse conditions.

The count of Bonny Best in Mr. Chase's house represented one of 30 standard-sized plants in the 48 x 200 greenhouse.

Table V. Comparative Amounts of Blossoms Set and Fruits Lost.

Tests with F. B. Chase, Eugene, Oregon, August, 1914.

Variety.	Number of clusters in actual count	Number of blossoms	Number of blossoms producing fruit	Number of blossoms lost	Per cent. of total set	Per cent. of total lost	Financial gain or loss computed
Bonny Best	204	1,352	643	709	47	53	$35.40
Jewel	32	229	86	143	37	63	7.00

Fig. 5. Typical clusters of Earliana tomato showing elongated habit of blossom bearing and scars where fruit was respectively set and lost.

College Greenhouses.

1914.

Four plants of each variety.

Bonny Best	39	242	137	105	56	44	5.00
Bonny Best	34	310	165	145	53	47	7.00
Jewel	41	271	126	145	47	52	7.00
Jewel	38	298	164	134	55	45	6.70
A-1	38	291	154	137	52	48	6.75
Comet	33	268	126	142	47	53	7.00
Earliana	22	246	81	165	32	67	8.00
Winter Beauty	46	374	253	124	68	32	6.00

Table VI describes the characteristics of varieties in their production and vigor of flowers, and length and vigor of clusters—items that are factors in light or heavy production of fruit. The variation of varieties in the condition of the pistil at pollinating time was observed during pollination in the greenhouse and tabulated here.

The majority of the varieties bear clusters of the moderately short, stout type, able satisfactorily to suspend a heavy crop of fruit on the cluster. Earliana shows a type distinctly different, being long, weak, and straggling.

Many of the blossoms on the Adirondack Earliana clusters bore double and even triple pistils and the fruits were consequently of no value.

Table VI. Investigations of Tomato Varieties.

Greenhouse observations of blossom clusters, blossoms, etc.

Variety.	Number of flowers to each blossom cluster	average length of clusters, inches	Vigor of 1. Blossoms 2. Cluster	Condition of pistil at time of reception of pollen	Remarks
Earliana	13	11	1. Good. 2. Too long for self-support.	Med. well forward.	Number of Earliana blossoms varies from 26–7; length of clusters 31″–8″. Characteristically long and not self-supporting with load of fruit.
Adirondack Earliana No. 2	Max. 23–45 Min. 4–11 Mean 11–19	11	1. Weak. 2. Elongated and straggling.	Well forward.	Blossoms very prolific. Growth after end of last blossom characteristic. Too many double and triple pistils. Flowers weak.
Jewel	Max. 8 Min. 5 Mean 5–7	6–8	1. Good. 2. Good.	Well forward to medium.	Clusters of flowers are typically stout. Clusters short.
Bonny Best	Max. 10 Min. 6 Mean 5–7	8–10	1. Very good. 2. Compact and vigorous.	Well forward to medium inclosed.	Flowers large, stout but not very numerous. Clusters are short and hold up fruit in good manner.
Comet	Max. 23 Min. 4 Mean 8–9	6–8	1. Fair. 2. Fairly compact and stout	Not well forward.	Produces a cluster of average length and moderate number of flowers.
Sutton's A-1	Mean 6	5–7	1. Good. 2. Good.	Medium forward.	Clusters short and compact; large amount of pollen; blossoms not many but stout.
Stone	Mean 7–9	4½–7	1. Good. 2. Compact, stout.	Well forward to medium.	Blossoms are not thrown as quickly as other varieties. Flowers many and clusters are stout.
Best of All	Mean 9–12	9–12	1. Fair. 2. Fair.	Medium well forward.	
Adirondack Earliana No. 3	Mean 9–11	.....	.....	.....	See Adirondack No. 2 above.

Summary of Variety Characteristics.

Earliana (Sparks'). The plant is medium small and not as vigorous as others, such as Jewel and Bonny Best; fruit borne on clusters peculiarly long and branching, producing prolific blossoms, many of which, in some strains, are weak and produce ill-shaped fruit. Adirondack Earliana Nos. 2 and 3 have been notorious in this respect in Station tests and have been inferior to a good strain of Earliana of the crop of 1913. Many plants of the former strains have been fasciated, producing 30 to 40 blossoms and no crown.

Fruit is medium to large, kidney or heart shaped, somewhat flattened, not always uniform or symmetrical; sutures at stem end in some specimens almost eliminated, but in others many and deep. The variety throws its blossoms very early and ripens quickly.

Skin of fruit medium tough, color uniform and bright red, ripening evenly; flesh dry, solid, and rather coarse grained and mealy; flavor mild, not acid, not pleasing, but dull and insipid.

This has been a leading greenhouse variety for years, but is rapidly being displaced. Its earliness of production has been its leading characteristic for recommendation, also its prolific blossom bearing. Strains with the roughness removed are not always reliable, and among the faults of the variety are its mediocre flavor and lack of uniformity of fruits.

It may possibly be used for a "very first" early product, but other varieties are now producing practically as much fruit the first month or six weeks of bearing, when prices are highest. Not quite fancy enough in taste and appearance for the fancy greenhouse product.

Jewel. Plant vigorous and medium large; clusters of fruits borne in compact clusters averaging 5 to 7 to a cluster; plant is a strong grower from seedling age onwards.

Fruit has averaged 4.5 to 5 ozs., medium size, shape vertically spherical although sometimes flattened at the blossom and stem ends; specimens as a rule symmetrical and smooth; cross-section spherical. Ribs or sutures are seldom present. Fruit often runs too large for fancy basket packing; inferior strains produce large as well as poorly shaped fruits.

Fruit ripens quickly, but strains vary in the percentage of fruit produced during the first month or six weeks; color bright red; skin tender; flesh solid and firm, juicy, evenly ripened, and fine grained; flavor pleasing, subacid; is excelled by Bonny Best.

Jewel has been grown for a number of years in Oregon but is rapidly being displaced by Bonny Best, which is more prolific and reliable. The fruit has good quality, and in good strains the variety packs easily in the standard crates; not always dependable. The vigor of the plants, clusters, and blossoms is a valuable characteristic. Has produced for the first month of bearing as many tomatoes in three years' test as any of the leading varieties, but the total amount for the season has been smaller than that of others.

Bonny Best. Plant medium large to large, vigorous, and a strong grower; clusters of fruit are short, stout, and bear on an average five to eight fruits of good size and appearance.

Fruit is medium to large, averaging for a large number of plants 6 to 6½ ozs.; shape vertically globular, sometimes partly flattened; usually regular and symmetrical; cross-section spherical; ribs are seldom present; fruit sometimes runs over size and too large for fancy packing; blossoms are strong and produce an abundance of pollen.

Fruit ripens quickly and from tests at the Station has ranked first in early production of tomatoes, being uniformly regular in this particular. Color an attractive red, skin medium tender, flesh firm and juicy, fine grained; the quality is excellent, being somewhat acid but very pleasing.

Bonny Best is not uniformly grown by Oregon greenhouse men, but it is bound to find more popular favor in the future. It has been undoubtedly one of the most reliable varieties grown at the Station, producing a large, early crop, and the setting of the fruit has been superior to that of many varieties. The clusters are of such a nature as to hold up the fruit, and the flowers

are strong. There seems to be no tendency at the present time for the variety to produce ill-shaped flowers and fruit.

The specimens often run somewhat larger than necessary, but this may often be due to an improper balance of feeding.

While there is room for improvement of this variety in certain respects, its attractive color, desirable size, and good quality make it one of the most profitable sorts to be grown under glass.

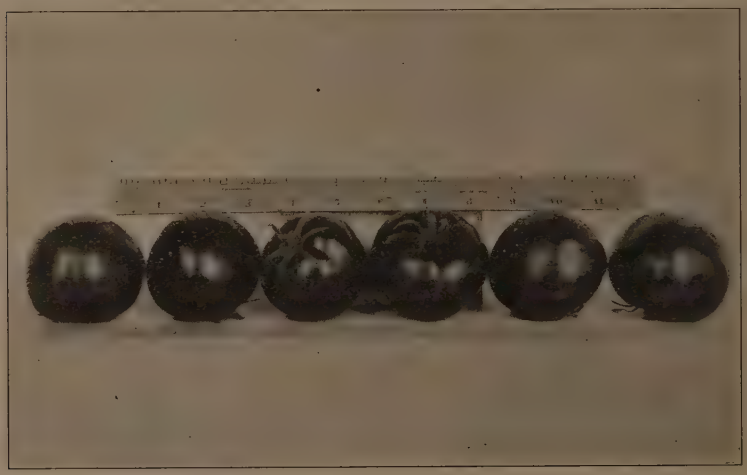


Fig. 6. Fruits of Comet and Peerless of desirable size and shape.

Sutton's A 1. Plant medium large, medium vigorous; clusters of fruit borne regularly, having 6 to 7 even-sized fruits.

Fruit is small to medium, usually globular but sometimes slightly ovate, not flattened, symmetrical and smooth in outline, cross-section spherical.

The variety ripens medium quickly and evenly. There are sometimes a few green spots, however, on the fruits. Ripe fruit is a bright red, very attractive, skin tender, flesh firm, moderately juicy, rather coarse grained; flavor mild, pleasing and not acid.

This is one of the best English sorts and for uniformity of size of fruits is not excelled by any American variety; the fruit often runs slightly undersize and the bearing habit has not been very prolific in tests at this Station.

The shape is very attractive, however, there being no signs of sutures or rough spots and the color is also very pleasing. A large amount of pollen is borne, and this variety probably excels most American varieties in the readiness of setting fruit.

This variety has proved dependable; the stock has been pure and reliable in the past tests. At this time of writing (November) the setting of fruits on check plants is far superior to that of other varieties.

Globe. This variety in one year's test has produced a crop of medium-sized fruits of splendid texture and fine flavor. The color of these for markets, however, is not so desirable as those having a solid red. The strain of Globe grown also produced only a fair number of fruits to the season, and the size was variable and not regular.

Adirondack Earliana Nos. 2 and 3. Strains of Earliana that have proved altogether inferior to a good strain of Sparks'. These strains seem to be overbred. The clusters are weak and will not stand up under a stress of heavy

fruiting. The strains are altogether too prolific in bearing blossoms for their own value, and many of the blossoms are double and triple, producing unmarketable fruits. Plants not vigorous, and strains are inferior in most respects.

Fig. 7. Heavy setting of fruit that makes for profitable tomato forcing.

Comet. Produces tomatoes of good shape and marketable size, as well as desirable flavor, but is not so early producing as other varieties. Under the influence of hand pollination this variety might be more acceptable. It is surpassed in value by other varieties named above.

Winter Beauty. One of the best English varieties, the seed of which was imported. This variety sets fruit remarkably freely and produces a large amount of pollen, which sheds easily. The fruits are not so attractive in color as those of A1, Bonny Best, and others, and the outline is not always symmetrical and smooth. The fruits are of good size, of splendid quality, and bear abundantly. It is valued in Europe as a forcing variety adapted for winter use. During the first four weeks of the season of 1914 it produced more fruit than any other variety and the total amount for the season placed it next to Bonny Best.

Peerless. A variety that was introduced by West, of Irondequoit, New York. This variety has received but one year's attention at the Station, but the showing it has made up to the present time augurs well for the future use of the variety. Globular in shape and of desirable size, it is easily handled in packing, and its smoothness and attractive color render it a highly desirable sort. Further trials with this variety and other prominent new ones will be carried on in 1915. The illustration in Figure 3 shows a cluster of "Peerless" tomatoes.

Stone has produced medium large to large yields in tests, but is a late-maturing sort, the bulk of the crop being produced during the second or third months of production.

GENERAL SUMMARY.

Tests with forcing tomato varieties under general greenhouse conditions show that:

1. Tomato varieties differ quite largely in the amount of fruit produced during various stages of the bearing season.
2. Since prices are highest early in the season, varieties that produce early and in prolific quantities are, therefore, highly desirable. In greenhouse tests of three years in the Station greenhouses, Bonny Best, Jewel, Earliana, and Sutton's A1 lead in the order named.
3. Early yields of tomatoes are greatly influenced by pollination. Both hand pollination and vine shaking show profitable net increases over plants that are left untouched.
4. The total amount of tomatoes for the season, moreover, is largely decreased where the vines are left untouched.
5. The total yield of tomatoes produced, as shown in Table I, was by the hand pollination method 441 lbs. and 0 oz.; by the jarring method, 393 lbs. and 8 oz.; by the check method, 289 lbs. and 4½ oz.
6. Large amounts of fruit are lost by unfertilized blossoms. The total of the latter in the tabulations in Table V is shown by actual greenhouse tests to be very nearly 50%. These actual counts are taken from a large number of clusters of various varieties.
7. The prolific bearing habits of varieties is affected by the number of blossoms ordinarily produced on clusters. Statistics in Table VI show the variations of varieties in this respect.

FRUIT-PIT STUDIES IN THE WILLAMETTE VALLEY.

By C. I. LEWIS.

For three years the Division of Horticulture has been conducting a study of fruit pit in a Willamette Valley orchard. The work was started in 1912. The study in this orchard was confined to a relation of an abundance of plant food to the prevalence of fruit pit. Plant food was applied in the form of commercial fertilizer.

Fruit pit is known under various names, such as "bitter rot", "brown rot", "bitter pit", "core rot", and "Baldwin fruit spot". This disease was fully described in the first Biennial Crop Pest and Horticultural Report, page 234. It is not necessary, therefore, to give an exhaustive description of this disease. There is some question whether it is a true disease, it seemingly having more of the characteristics of a physiological break-down. Disease or not, however, and by whatever name called, the trouble has been quite prevalent in Oregon for a number of years.

The general appearance of this trouble is shown by spots. These may be only on the surface, finally causing a depression in the skin. The pits may not show on the outside, however, but may be scattered throughout the flesh. Occasionally it takes the form of a "dry rot" around the core. In whatever form it occurs, it makes the apples unsalable.

In addition to the experiments that have been carried on in this orchard, the Division has also conducted experiments in other fruit valleys of the State. The orchard selected for this work is typical of the better class of apple orchards of the Willamette Valley. It is a mature orchard consisting largely of Esopus Spitzenberg, having a few scattering trees of Monmouth, or so-called Red Cheek Pippin. The orchard had been troubled with this disease for a number of years and the owner had asked the Institution to give him some assistance. The work was conducted on an extensive scale, using large plots, with a minimum of twenty-five trees.

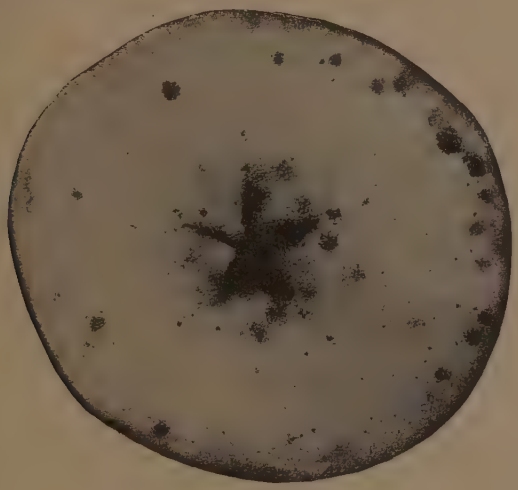


Fig. 8. Fruit Pit.

Nine plots were used, in which fertilizers were applied either as a single ingredient or in combination. The fertilizers used and the rate applied to the acre are shown in the following table.

Plot 1—Muriate of potash	200	lbs.	to the acre.
Plot 2—Sulphate of potash	200	"	" "
Plot 3—Nitrate of soda	100	"	" "
Plot 4—Dried blood	150	"	" "
Plot 5—Acid phosphate (8 per cent)	300	"	" "
Plot 6—Gypsum	100	"	" "
Plot 7—Ground bone	300	"	" "
Plot 8—Combination			
Muriate of potash	200	"	" "
Dried blood	150	"	" "
Plot 9—Combination			
Muriate of potash	200	"	" "
Ground bone	300	"	" "
Dried blood	150	"	" "
Plot 10—Ground limestone	1500	"	" "

Fertilizers were applied early in the spring of each of the years 1912, 1913, and 1914; they were sowed broadcast and later harrowed into the ground.

The experiments were directly under the charge of Mr. F. C. Bradford, who was formerly connected with the Experiment Station. The results for the fall of 1914, however, were checked up by Mr. A. F. Barss.

The prevalence of the pit in this orchard is somewhat peculiar, in that the ends of the rows were relatively free while a plot extending through the center of the orchard was quite severely attacked. Investigation failed to show any good reason for this distribution. There has also been a great fluctuation during the various seasons. This fluctuation has not only occurred in the fertilizer plots, but has occurred in the check plots, indicating that the prevalence of this condition is not necessarily fixed. This fluctuation has also been observed in other orchards located in other parts of the State.

In checking results, a given number of apples from each tree were cut at harvest time, in all 20 or 30 boxes of fruit being cut each fall. In addition, some fruit was placed in storage to determine whether or not the trouble was aggravated by storage.

The results obtained from the fertilizers were far from conclusive; and it will probably be necessary to extend the experiment through at least another two years. So far, the only results have been secured from the use of gypsum and muriate of potash; yet even these results are so slight over some of the check plots that we do not feel justified in recommending the application of these ingredients extensively in our orchards. We would suggest, however, to those who wish to try fertilizers to control this condition in the Willamette Valley, that they experiment conservatively with gypsum, lime, and potash.

A decrease in fruit pit by the use of gypsum in 1914 over 1913 was 44 per cent; the decrease from muriate of potash was 33 per cent. On the other hand, there were two check plots, one of which decreased 42 per cent and one 41 per cent. One check plot, however, increased 4 per cent. Owing to a misunderstanding, we failed to check on the lime plots this year (1914), and hence are unable to report on these. The results of the various fertilizers for the three years have not been consistent, there being a considerable fluctuation from year to year.

It was noted in the orchard this past fall that the fruit pit seemed to be more prevalent in the more mature specimens of fruit. These specimens, which were highly colored and had matured relatively early, were more liable to be affected with the pit. Whether or not this was due to the fact that the pit is more easily detected in mature specimens, or whether the pit caused early maturity of the apple, has not been ascertained.

In 1913 some apples were placed in storage to determine whether or not the fruit pit increased in storage. They were stored promptly after harvesting, and were cut open on February 24. Out of a total of 1059 specimens, only 25 showed the pit, and in these cases, its extent was not greater than was commonly found on the apples examined the previous October. This seems to indicate that, as far as the season of 1913 is concerned, the pit did not develop

in storage. Some reports have been received, however, from other sources indicating that at times there is a rapid development of the pit in storage. However, this development may mean simply this:—that as the fruit matured and became thoroughly ripe, the presence of the pit was more easily detected.

We shall have other reports to make, from other orchards located in various parts of the State, and we hope to continue the present investigations for several seasons.

I would suggest to the growers of the State of Oregon first, that, in trying to control this condition with fertilizer, in no case mixed fertilizers be applied, but only ingredients of which the composition is defintely known; and, second, that if fertilizers are applied, the growers leave ample check plots and take pains to check at harvest time the prevalence of this disease on the fertilizer plots as compared with the check plots. I would urge, however, that since the Experiment Station is working on an extensive scale, growers are not justified in spending large sums of money in trying to check this disease with commercial fertilizers.

THE PEAR AS AFFECTED BY MOISTURE SUPPLY.

By A. F. BARSS.

Orchardists in many of the important fruit sections of the West have come to realize that for the most satisfactory results in fruit production it is frequently necessary, or at any rate best, to supplement the natural moisture supply in the soil with artificial irrigation. Many investigators have carried on experiments, in this connection, to determine the effect on the fruit itself and on the total crop production, of applying water by various systems and in varying amounts. As far as is known, however, little has been recorded as to the effect of irrigation upon the tree or its fruiting habits. In order to meet the need of an understanding of this phase of the irrigation problem, an investigation was commenced in December, 1912, for the purpose of determining the effect of varying amounts of water upon the growth and tissue structure of the pear tree.

As a contribution to the general problem as stated, this present preliminary report contains a brief discussion of particular experiments conducted with a view to determining the gross effects of supplying different amounts of water under controlled conditions.

Inasmuch as any investigation carried on outdoors is subject to interference from unexpected and unavoidable changes in weather, differences in soil, and other influencing factors, it was decided to conduct the first study under greenhouse conditions where the work could be entirely controlled. Although these conditions were necessarily far different from those found in the orchard, yet the results are such as to warrant the opinion that they may be of value when adapted to general orchard irrigation. Strictly speaking, no matter how significant the results here reported may appear, they should be tested out under natural orchard conditions before an attempt is made to establish any final rules.

In establishing the experiment, forty-eight uniform Bartlett pear trees dwarfed on Angers quince roots, three years old from the bud, were set in pots and taken into the greenhouse in December, 1912. These were then divided into four lots of twelve trees each, the lots to receive identically the same treatment in every respect save one, the application of water, which was to be varied in the following manner: By keeping the pots in Lot L standing in water, the trees in this lot were to be assured a continuous supply of water, hence as much water as they could utilize; those in lot F were to receive the same total amount of water as L, but in twice as frequent applications of one-half the quantity each time. The trees in lot M were to receive half as much water as lot L (or lot F); while the final twelve trees making up lot S were to receive as little water as possible and yet remain alive.

Throughout the first season, careful record was made of any differences that were apparent in the behavior of the trees in the lots; and these observations have been embodied in the following summary, which is given in full because of its value for purposes of comparison with the latter results.

Summary of First Year's Work.

1. Different amounts of water produced no perceptible difference in the time required for the trees to leaf out fully.

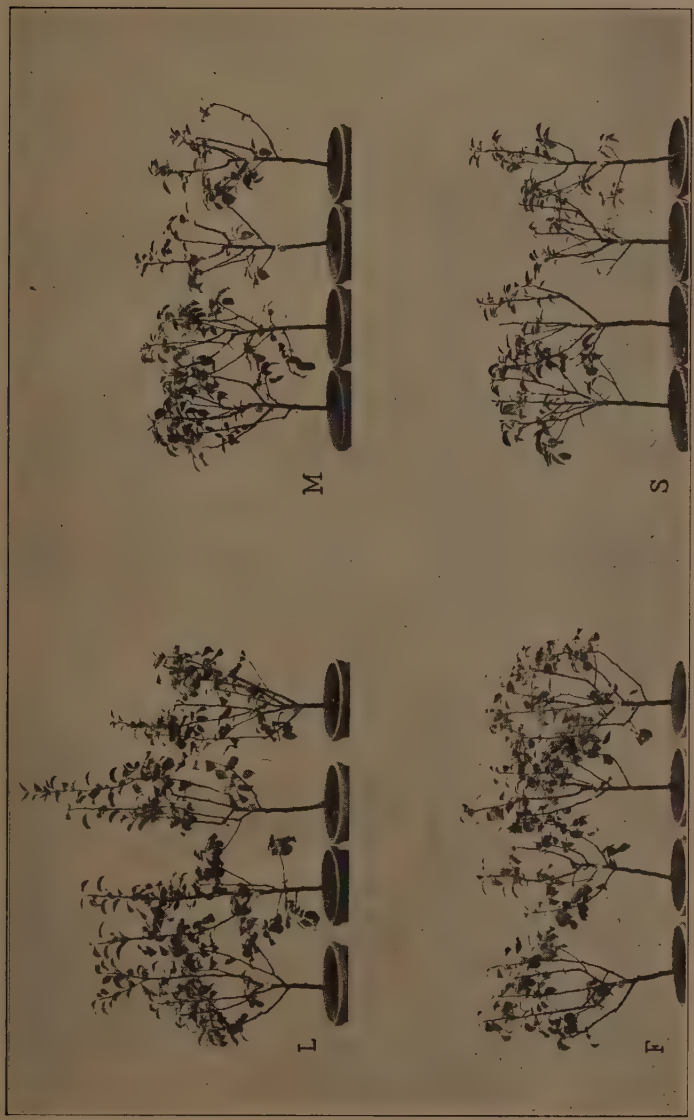
2. Trees receiving the maximum amount of water developed larger and more brightly colored leaves than trees receiving half the amount, although the latter developed good, healthy leaves. Trees given the minimum amount of water developed small, dull, grayish-green leaves.

3. Trees in all lots started to form terminal buds at the same time, buds so formed growing out again on some trees in lots L and F.

4. Large increases in amount of water above the minimum required by the trees lengthened the growing season. A small increase in the amount of water did not lengthen the growing season.

5. Trees receiving water up to their full capacity made greatest wood growth; trees receiving the next largest amount of water made the next greatest

Plate I.



Four typical trees from each lot. Photograph taken June 26, 1913, near the close of the first season.

growth. The other two lots, M and S, did not differ materially from each other in amount of growth, which was much less than in lots L and F.

6. Lenticels of trees receiving the greatest amount of water were larger and more conspicuous than those of trees receiving half the amount, or trees receiving a minimum amount of water. There was no perceptible difference in lenticels between lots L and F or between lots M and S.

7. Growing wood on lots L and F showed more green than that of lots M and S. When matured and dormant, the wood on lots L and F was darker than wood on lots M and S and showed less green, the color being medium dark greenish-brown in the former and light greenish-brown in the latter. Late growths, put out by L, remained green through the winter.

The Second Season's Work.

The second season for the experiment commenced in December, 1913, and continued to August, 1914, during which time all lots were given the same treatment in every respect save in the matter of watering, this being varied in the same manner as previously outlined. The total water applied to each tree between December and August was:

Lot	L.	F.	M.	S.
Amount in quarts	69.5	66.0	35.0	12.0

Throughout this period careful measurements and observations were made at frequent intervals to determine any existing differences in condition of trees, in blooming, fruit development, new branch growth, foliage, etc., which differences are brought out in this report.

Condition of Trees and Starting of Growth.

As to the general condition of the trees at the beginning of the second year's work, it will be sufficient here merely to state that all trees seemed to be quite uniformly in very good condition. Throughout all the lots, it was noticeable that the branches which had made a second growth during 1913 or which did not commence growing until late in that season, were still green in color, fairly tender in texture, and in many cases had died back some distance from the tip. The buds on such twigs were small and poorly developed.

When brought into the greenhouse, all the trees were absolutely dormant, and for the first four weeks all lots were subjected to the same identical moisture and temperature conditions, with the result that all four lots seemed to start almost evenly. In one month from the time the experiment was set up for the second season, that is, by January 22, the fruit buds were beginning to swell and show a little green. By January 26, nearly all fruit buds in all lots were beginning to unfold. On a limited number of trees in all of the lots it was noticed that few or none of the buds made a start at this time. Lack of vigor was at first suspected, but later observation showed the presence of no living fruit buds, or at most only a few, while the leaf buds opened later at the proper time.

Study of Blooming.

Differences in blooming among the lots were more noticeable with respect to the number and size of the clusters than with respect to the time of blossoming, there being no apparent difference in this last respect among the four lots. The lot receiving the least water had the smallest number of clusters and these were found largely on spurs. The other lots did not differ from one another a great deal, lots L and F being almost identical, while M had a smaller number of clusters with a higher percentage of them borne on spurs than in L and F.

Table I—Study of Flowers.

Lot	L.	F.	M.	S.
Total No. clusters	75	75	66	29
Total No. flowers	393	395	405	179
Average No. flowers to each cluster	5.23	5.26	6.13	6.17

Table I gives the number of clusters and flowers in each lot. It shows, also, that the lots receiving the most water had the smallest average number of blossoms to a cluster. It may not be possible to give a positive explanation for this, but it seems probable that the lower average for each cluster in L and F is due largely to the presence of so many small one- or two-flowered buds, rather than to any reduction in the number of those with five, six, and seven flowers to the cluster. This condition may be due in some measure to the large number of axillary buds present in lots L and F and to the blasting of weaker buds in the other lots, which under more favorable conditions in L and F were kept alive and forced into growth. The lot receiving the least water had only three clusters with less than five flowers, and none with more than nine. Lots L, F, and M, on the other hand, all had a large number of few-flowered clusters; that is, clusters with less than five flowers, as well as a large number of the clusters with from five to ten or more flowers.

In the relative distribution of the clusters to the twelve trees in each lot, lots L, F, and M rank together in having two-thirds of their trees with five or more clusters to the tree, whereas lot S has but one tree with over four clusters, due, no doubt, to the blasting of so many fruit buds. While blighting of buds occurred to a slight extent in lots L, F, and M, yet in lot S it was much more frequent. This may probably be attributed to the reduced water supply.

Toward the close of the season, that is, in late July and early August, there was quite an extensive second bloom, but no attempt was made to pollinate the flowers. Lot L had one cluster of ten flowers; lot F, one cluster of eight flowers; lot M, twelve clusters with an average of 6.25 flowers in each cluster; while lot S exceeded the other lots in having seventeen clusters averaging 6.29 blossoms each.

Study of Fruit Development.

Winter Nelis pollen having been found to fertilize Bartlett satisfactorily, a tree of this variety, brought in and forced along with the others, was used as a pollenizer. All open blossoms in all the lots were hand pollinated every two or three days, and in this way probably every blossom received pollen when the pistils were in a receptive condition. Table II, containing the fruit counts on four different dates, follows.

Table II. Fruit Counts.

Lot	L.	F.	M.	S.
Total No. flowers	393	395	405	179
No. apparently set:				
March 9	75	111	91	25
March 25	18	15	27	14
April 4	16	8	24	2
April 18	13	8	20	..

Even though a few days after the pollen was applied a large percentage of the blossoms showed signs of having been fertilized, it appears from Table II that even at the first fruit count the fall of blossoms was very large. In the later counts, it was found that many fruits which were apparently well started, fell, and all but a few of these, on being cut open, were found to have already begun to develop seeds. While the dropping was very great in all lots, there was a general tendency for more fruit to set and to continue development in lot M than in the others. There was little difference between L and F. The 100% drop which occurred in lot S can hardly be attributed to anything else than to a lack of water.

It was noticeable that the circumstances attending the drop in lot S were distinctly different from those observed in the other lots. In lot S, the fruits grew quite normally for approximately three weeks, but from that time on increased very little in size. In color, they were a dull green and showed a decided lack of vitality in every way. The stem was undersized and did not support the fruit well, usually appearing half limp. Before the fruit finally dropped, it had generally hung for some time in a shriveled, withered condition. In Lots L,

Plate II.

A comparison of representative trees from each lot. Upper photograph taken April 1, 1914; lower photograph taken July 6, 1914.

F, and M, on the other hand, the fruit which was about to fall turned yellow near the point of attachment and dropped soon after, while still quite turgid.

Frequent examination and measurement of the fruits showed that in both size of fruit and in rate of growing, lots L and F were almost identical, while lot M fell considerably below. When the matured fruits were picked, it was found that the average weight for those in lot L was 202.6 grams each, in lot F, 236.9 grams, and in lot M only 93.5 grams.

The fruits in lots L and F in general appearance were so nearly alike that no distinctions could be made. They were all of commercial size. The color of the immature fruit was a bright, clear green with a yellowish tinge, which became a clear yellow on ripening. The surface was generally uneven and more or less obscurely ribbed. In lot M, on the other hand, the fruits were all appreciably smaller and were smooth surfaced. The color was a dull, bluish-gray green instead of a bright clear green, which, however, changed to the same general yellow color as the others, when ripe. These fruits also had a different "feel", for while they were perfectly solid, they felt less crisp and more yielding than those in the other lots. In all lots there was a considerable variability in the form and size of the fruits, and a slight unevenness in time of maturity.

The most striking difference, and one which widely separated lot M from lots L and F, was in the quality of the ripened fruit. The two latter lots appeared to be identical in having all their fruit tender very juicy, and what would normally be called of high quality for Bartlett pears. In M, however, the skin of the fruit was tough and the flesh itself was never tender, but rather of a noticeably tough texture, as though partly withered; while the general quality was so poor and the flavor so astringent as to make the fruit decidedly undesirable for eating.

Study of New Branch Growth.

The most noticeable variation in response to the application of different amounts of water, was found in the development of new wood. All four lots started vegetative growth at about the same time and in about the same general manner. Measurements, as taken from time to time, were made uniformly throughout, and include the growth from the end of the older wood to the last distinct node on the new shoot. All growth which exceeded 1.5 cm. in length was designated vegetative shoots or branches. Tables III and IV give the figures obtained from the measurements taken March 5 and April 22.

Table III. Branch Growth on March 5.

Lot.	L.	F.	M.	S.
Total branch growth (in cm.).....	956.25	1116.5	663.25	494.25
Average growth for each tree (in cm.)...	79.7	93.0	55.3	41.2
Total No. of branches.....	148.0	154.0	118.0	104.0
Average No. of branches for each tree ..	12.3	12.8	9.8	8.7
Average growth for each branch (in cm.).	6.46	7.25	5.62	4.75

Table IV. Branch Growth on April 22.

Lot	L.	F.	M.	S.
Total branch growth (in cm.).....	2248.5	2685.0	939.75	529.25
Average growth for each tree (in cm.)...	187.35	223.75	78.31	44.10
Total No. of branches.....	138.0	154.0	111.0	89.0
Average No. of branches for each tree ..	11.5	12.8	9.25	7.40
Average growth for each branch (in cm.).	16.22	17.43	8.46	5.94

On comparing these tables, the lots are found to be arranged in every respect in the descending order F, L, M, S. The differences among the lots were not extremely pronounced at first, but a comparison with the later figures shows the lots to have become widely separated. For instance, where on

March 5 the difference in average amount of growth for each tree between S and F was in the proportion of 44 to 100, by April 22 it had become 19 to 100.

During May, and again in August, interesting developments in the way of new growth were observed and recorded. The withholding of water from lots M and S, seemed to have the effect of artificially forcing the trees in these lots into a state of partial dormancy in May and June. At the same time, however, and this was after the regular growing had ceased, it was noticed that in the other two lots, L and F, many buds were swelling, turning pale green, and showing signs of starting new growth. This phenomenon, while occurring in a few trees in lot F, was practically limited to lot L, and was due, no doubt, to the abundance of water applied to these lots. The completed second growth in lot L amounted to twenty new shoots with a total length of 330 cm., and fourteen new spurs; in lot F it totaled six new shoots, 42.75 cm. in length, and four spurs.

Fig. 9. A comparison of all trees involved in the experiment. Photograph taken in the greenhouse July 6, 1914.

During late July and early August, lots L and F developed a few cases of a third growing, but most of the trees had lost considerable foliage and the leaves still hanging were turning yellow. At this same time, however, the other two lots, that is, lots M and S, seemed suddenly to revive and to start growing afresh, so that when the trees were forced into dormancy toward the last of August, lot S, with lot M a close second, were in every way much more active than the other lots. During this new growing period seven trees in lot M grew forty-seven new spurs and sixteen new shoots for a total of 106.75 cm., while one tree developed three shoots of a third growing for a total of 68.5 cm. In lot S, every tree developed a fresh supply of leaves, and thirteen new shoots were formed for a total of 49 cm. of growth. At the same time, a large number of blossoms were put forth, as was previously noted.

While this new activity was going on in lots M and S, the other two lots were just going into a state of natural dormancy with their first growth and most of their second growth well hardened.

In the remainder of this report only the first growing will be considered.

Besides the differences in length of growth and number of vegetative shoots there was a difference in the length of the internode. The average internodal,

length was estimated by counting the leaves and dividing the total linear growth by the number thus obtained. This method is not beyond criticism, but gives some basis for comparison. The resulting figures, which may be designated as the average wood growth to the leaf on the new shoots, are as follows:—

Lot.	L.	F.	M.	S.
Average wood growth to the leaf (in cm.)	1.246	1.305	0.896	0.703

The difference was really much more marked than the figures would tend to show. Accurate measurements of the internodal spaces near the middle of several new shoots in each lot, showed that in both lots L and F, a few internodes were 3.5 to 4 cm. long, while a greater number averaged 2.5 to 3.5 cm. On the other hand, in lots M and S, which were nearly alike in this respect, the internodal space rarely reached greater than 2.5 cm., while the average was very much less.

A not inconsiderable difference occurred in the diameter of the new growth. Measurements were made with a caliper of a large number of the more vigorous growths in all four lots. Each shoot was measured in three places: at approximately 2 cm. from the base; at the mid-point; and 2 cm. below the tip, care being taken to avoid measuring at a node or any abnormally swollen or shrunken place. These measurements appear in table V.

Table V. Average Diameter in mm. of new Branch Growth on April 9.

Lot	L.	F.	M.	S.
Near base	5.11	4.66	3.92	3.32
Midway	3.83	3.64	2.98	2.41
Near tip	3.07	2.87	2.61	2.02
Average diameter	4.0	3.72	3.17	2.58

The lots are here found to be arranged according to diameter in the descending order L, F, M, S. The diminishing of the supply of water apparently caused the new growth to be not only shorter but much more slender than where a large amount of water was applied.

In addition to the differences already noted, another slight difference was seen in the number of instances where more than one vegetative shoot, or where a shoot and fruit grew from a single bud. The number of cases of these so-called multiple growths from single buds was greatest in F, and nearly as great in L and M, but very much less in S. From the fact that, in such cases, more fruit persisted in lot M than in any of the others, and none remained in S, it is apparent that a large supply of water tends to favor vegetative development at the expense of quantity of fruit, while the lack of water results in a reduction of both vegetative and fruit growth.

The Rapidity of Growth and Length of Growing Season.

From measurements made at various stages of growth, it became evident that the amount of growth was greatly increased by adding the larger amounts of water. It is also apparent that the bulk of the growth in lot S, especially, and to a considerable extent in lot M as well, was made within the space of two weeks, while in lots L and F, growth continued until much later. These facts are brought out in Table VI.

Table VI. Showing Average Gain (in cm.) for each Tree at Different Periods.

Lot	L.	F.	M.	S.
March 5 to March 26	83.06	103.9	21.5	2.9
March 26 to April 22	24.6	27.1	1.5	0.0

From Table VI, as well as from other figures obtained for the individual trees, it is very evident that the larger amount of water tends to extend materially the growing period of the trees. Furthermore, lot F with the more frequent applications of water showed a slight increase in all these points over lot L, which received the same total amount of water but at wider intervals of application.

Study of New Spur Growth.

In order to have a definite understanding as to just what was to be called a spur and what not a spur, it was decided arbitrarily to designate as a spur any growth which did not exceed 1.5 cm. in linear growth. Very many of these spurs seem to be merely a whorl of leaves with a bud developed in the center, others appear rather to be very much shortened branches. All of these are to be called spurs in the following discussion.

In studying the spur growth, the question arose as to whether or not the trees receiving the greater supply of water would form more spurs than those trees receiving less water. That there was no very material difference among the four lots in this respect is shown by the following figures giving the number of spurs in each lot:

Lot	L.	F.	M.	S.
No of Spurs	293	333	286	309

The large total number of spurs in lot S can probably be accounted for by the low number of buds that made growths long enough to be considered branches. It seems probable that under the retarding influence of the reduced supply of moisture in lot S, many of the new growths remained spurs, whereas corresponding growths in lots L and F, under the stimulus of the additional supply of water, kept on growing, and so became shoots.

In regard to the general condition of the spurs, it may be said that the spurs in lot L and F were in every case larger, healthier, and more vigorous than those in lots M and S. Between the spurs in lots L and F there was no noticeable difference. In M, the spurs seemed to be somewhat larger than those in S, otherwise there was little marked difference. In both M and S, the spurs seemed to reach their full external development very early and to become hardened much sooner than in the other lots. On April 22 the bud and spur body were a bronze-green color in M and S, while both were a bright green color, in most cases, in L and F.

Study of Foliage.

In considering the effect of irrigation on the foliage, an attempt was made not only to find any difference that might exist in size, shape, and appearance of the leaves, but also to determine whether or not the amount of water applied had any influence on the number of leaves which developed on spurs and on shoots.

A count of the leaves on all the spurs showed that no definite difference existed among the lots as to the number of leaves that would develop to a spur.

On counting the leaves on the shoots or branch growths on March 26, the following averages were obtained:

Table VII. Average Length of Shoot and Average Number of Leaves to the Shoot.

Lot	L.	F.	M.	S.
Average length of shoot (in cm.)	13.95	15.02	8.40	5.94
Average No. leaves to the shoot	11.19	11.51	9.37	8.45

From Table VII it is clear that the proportion of shoot to leaf growth was not the same in all lots. Instead, lot S averaged considerably shorter

Plate III.

A comparison of the fruit from the different lots. Photograph taken July 6, 1914.

in linear growth to each leaf than did the other lots. The four lots were arranged in respect to the amount of linear growth for each leaf in the descending order F, L, M, S. This makes it appear that, to some extent, the number of leaves may have been determined within the bud before growth started rather than upon the length of the growth afterwards.

From leaf samples, collected and weighed in order to bring out any existing differences in weight, it is apparent that, on the average, the leaves in the lots receiving most water were far heavier than those in the lots receiving less water. Of the two lots L and F, the former seemed to have the greater weight to its leaves. Between M and S, lot M had the heavier leaves.

A further difference in the leaves in the four lots became noticeable toward the last of April. Quite a large number of leaves began to show a blackening in large irregular spots, which were soft at first but later became brittle. The cause of this charring was not definitely known, but it seemed like the effect of a sunburn due to the intense heat under the glass, since there was no protection over the trees to keep off the direct rays of the sun. This phenomenon occurred with equal severity in lots L and F, whereas but one tree in lot M and none in S was affected. This makes it appear that there is a physical difference in the structure of the leaves in the lots, at least as to their ability to withstand intense sunlight.

The gross differences between the leaves in the several lots did not show up when all were starting, but became noticeable when the trees began to be affected by their special treatment. Little if any difference was found between lots L and F. Both had very vigorous leaves, averaging large, rather coarse in texture, more or less uniform in shape, and longer and broader than the leaves in M and S. In L and F, also, the newer leaves were light, yellowish-green in color and covered with abundant pubescence. The older leaves, after they attained full size, lost this, or else it was distributed over so large a surface as to be less noticeable, and they became a bright, shiny, dark green. These leaves were always turgid and remained flat open, standing away from the branch.

In lot M, the leaves generally averaged smaller, although fairly uniform in size; they also remained flat open. The chief difference, other than size, was the color, which was a dull green rather than a bright dark green as in lots L and F.

In lot S, the leaves occurred in all sizes and shapes, those trees which made the most vigorous growth showing the greatest uniformity in this respect. Generally speaking, the leaves were much smaller than in L and F, and even than in M, with the greater number rather pointed and narrow, though many were almost circular. The undersides showed considerably more pubescence than in the other lots. In lot S, too, the leaves tended to stay half closed and their petioles were very slender, weak, and flaccid, so that the leaves hung partly limp most of the time after the trees first began to be affected by drought. The general color of the whole lot was dull green, with a dusty grey effect, due to the backs of so many leaves showing.

Two other differences that occurred among the lots were differences in the formation of buds and in the formation of callus tissue over cuts. The terminal buds in lots L and F were formed much later than in M or S because of the longer growing season of the former. Besides this, all the buds that developed in lots L and F were much larger, plumper, more vigorous, and of a less indurated appearance than the corresponding buds in the other lots. Lots L and F were very similar in bud characters. The trees in lot M had buds slightly larger and more vigorous than in lot S, in which they were all very small, especially those in the axils of the leaves, and of a reddish-black color.

In respect to vigor of callus formation it was found, on examining the cuts made previous to the present season, that most of the wounds in lot L had nearly, if not entirely, healed over. In F almost as large a number were well covered. In M, however, there were only a few cases where callus formation had even started; while in S there was not the slightest sign of a single cut being covered over. The cuts made this season showed the same differences.

In L and F some of the cuts made as late as March were completely calloused over by May 1; healing had also begun in some cases in lot M, but in S none of the cuts showed any signs of callus formation.

The results of the experiments as brought out in this preliminary report are made more interesting when the results of the first season's work are compared with those of the second year. The apparent cumulative effect of the different treatments accorded the four lots will, in all probability, be even more marked with the continuation of the experiment.

Summary of Second Year's Work.

1. The water supply did not influence the time of starting of buds.
2. In a comparison of the four lots, those which received an excess of water, L and F, showed greatest number of blossom clusters; greatest average size, greatest average weight, and highest quality of fruit; greatest total amount of wood growth; greatest number of branches; greatest average linear growth to the branch; greatest average diameter of wood growth; longest internodal spaces; greatest number of cases of multiple growths from single buds; largest, most conspicuous, and greatest number of lenticels; greatest size, weight, and vigor of leaves; greatest number of leaves affected with the apparent "sunburn"; longest growing season; largest, healthiest, and most vigorous buds; readiest formation of callus tissue.
3. The moderately watered lot, M, exceeded the other lots in having the largest total number of blossoms and greatest number of fruits.
4. The scantily watered lot, S, led the others only in having the largest average number of flowers to the cluster.
5. Although the figures in the moderately watered lot were considerably lower than the figures obtained in the lots receiving their full capacity of water, still this lot, M, exceeded the scantily watered lot in every instance, save the one just mentioned.
6. Of the lots which received the excess of water, the one which received water less frequently showed a superiority only in that it had the greater number of fruits, greater average weight to the leaf, and greater average diameter of new growth. On the other hand, the lot watered more frequently, slightly exceeded the other in all other respects.

STRAWBERRY VARIETIES IN OREGON.

The Relative Importance of the Strawberry Crop.

By V. R. GARDNER

Taking the United States as a whole, the small fruit industry ranks third in importance among fruit crops, the total value of the small fruit crop in 1909 being nearly $30,000,000. (1). Only the pome and stone-fruit industries surpass these figures.

In Oregon these various fruit crops rank in importance in the same order. Among the small fruit crops the strawberry holds first place. Indeed, in many states, Oregon included, its commercial value is nearly, if not quite, equal to that of all the other small fruits put together. The census figures, of course, take into consideration only the commercial strawberry industry, the products of which are raised for market. Besides strawberries that are raised to sell, there are large quantities raised for home consumption. All told, these berries from the kitchen gardens may not total as many crates or as many tons as the regular commercial crop, but they certainly make the grand total much larger than is commonly supposed.

The Coming and Going of Strawberry Varieties.

The question probably most frequently asked by those interested in strawberry growing is, "What variety, or what varieties, shall I plant?" This is not only the question of the person who has a garden plot where he raises a few berries for his own use, but it is the question of the amateur who grows a few dozen or a few hundred crates of berries for the market, and of the professional who measures his crop by the ton or by the carload. Indeed, it is a question the correct answer to which means much more to the two latter classes than to the former. The difference between the right and the wrong variety often means the difference between a paying and a losing crop. It is interesting to note, that the man who is growing his product for the market usually asks his question in the singular; i. e., "What variety (not what varieties) shall I plant?"

It is not surprising that this question is asked repeatedly, for there is always the possibility that the correct answer will be different this year from what it was a year ago. Such is not the probability, but it is a possibility. This is not because old varieties are "running out," deteriorating in some way, though now and then such a claim is made; nor is it because markets or market demands are materially changing and calling for something different. It is because of the fact that new varieties are constantly appearing. Each season sees its dozens or scores, or even hundreds of new varieties introduced, advertised, exploited; and each season sees as many disappear from cultivation. Many of the newest, most widely advertised and exploited, are the quickest to drop from sight; but now and then one proves its worth and stays. The grower is interested in this one out of a hundred, or out of a thousand possibly, for it may mean much to him in a business way. For each grower to try out the new varieties from year to year with the idea of occasionally finding one promising for his conditions, is obviously not practicable. It might be interesting, but it would prove very expensive. The variety test of the Experiment Station aims to sift the hundreds of varieties that are introduced, pass judgment upon them, and classify them according to their ability or inability to meet the environmental and market demands of the section under consideration.

To the extent that such a test furnishes reliable information regarding present-day varieties, it is of temporary and local value; i. e., it is of value for the section under consideration and for as long a period of time as these particular varieties are before the public. To the extent that the data presented

(1) Thirteenth Census Report of the U. S. 1910. Agriculture, Abstract Farm Crops, by States. P. 49.

are of such a nature and arranged in such a way that general conclusions may be drawn, that interpretations may be made, regarding varieties in general, it is of more general and permanent value. It is believed the variety test here reported gives sufficiently definite recommendations regarding a number of strawberry varieties to be of some use to the grower. An attempt has also been made to interpret some of these data and reach one or two general conclusions.

History of the Strawberry Variety Test.

This variety test was begun in the spring of 1908, when plants of a large number of varieties were obtained from nurserymen, seedsmen, and strawberry specialists in various parts of the country. Plants of other varieties were obtained in the fall of 1908; still others in the spring or fall of 1909, 1910, 1911, and in the spring of 1912. Thus some of the varieties reported upon have been under observation for six successive seasons, and, in one location or another, have borne five crops. Others have been under observation for only five years, or four, or three. Only a very few are reported upon that have been under observation for but two seasons. The number of plants of each variety grown at any one time varied from 12 to about 500. In most cases, there were about 40 plants of each variety on trial each season.

All were set in rows 42 inches apart and from 12 to 15 inches apart in the row. Runners, except the few occasionally needed to start a new plot, were removed and the plants grown in hills, as is the common practice in the State. The first season after setting, flowers and flower buds were also removed to force all the energies of the plant into crown, root, and leaf formation.

The soil in which all the plants were grown from 1908 to 1911 (inclusive) is a heavy clay loam, a soil that is naturally unfavorable for strawberry culture. It is rather poorly drained, inclined to cement in the winter and to bake in late spring and summer unless very carefully handled. Though there are but few days each winter when the ground freezes at Corvallis, the soil in question is such as to heave when there is the slightest cause for it, and thus to increase rather than decrease what would be normal winter injury. During the seasons 1912-13 the test was conducted on a different piece of ground. The soil of this plot is distinctly lighter than that of the plots where the plants were grown the four preceding seasons, but it would still be classed as a moderately heavy clay loam. Both plots received frequent cultivation and such hand hoeing as was necessary. The average of all the conditions surrounding the plants has constantly been such as naturally to tax their vigor and vitality, and, through these factors, their productiveness. Their average performance in the Station tests may therefore be considered as something less than what might be expected of them under really favorable conditions. Furthermore, the conditions of the test have been such as probably to increase or accentuate the apparent differences in performance between the poor and the good. That is, the naturally weak or semi-weak plants have been suppressed to a relatively greater extent than the naturally strong and vigorous.

This experiment was inaugurated by C. I. Lewis. The observations, notes and descriptions made in 1908, 1909 and 1910 were by Messrs. C. A. Cole, C. C. Vincent and W. H. Wicks; those made in 1911, 1912 and 1913 were by the writer, aided by F. V. Tooley in 1911, and A. F. Lafky in 1912-13.

The Variety Descriptions.

In preparing the variety descriptions for this report, practically no attention has been paid to characters primarily of taxonomic importance. Descriptions of this sort have been made and are on file for use when they may be required; but the grower is little interested in the detailed characters that may possibly enable him to distinguish one unimportant variety from another. The characters here described are such as are of importance in determining the commercial rating of the variety. First the grower wants to know about the size, vigor, and health of the plant, the number and size of its crowns; since yield for each acre and duration of the plantation depend directly upon these factors. He wants to know about the plant-making abilities of the variety,

for his fields must occasionally be renewed. He wishes to know about the habit of the plant, because upon it depends to some extent the distance apart for planting, the susceptibility of the variety to frost, and the way in which the berries are held up from the ground. Second, he wants to know the sex and the flowering season of his variety. Third, he wants to know whether the fruit stems do or do not hold the berries off the ground. And fourth, he wants to know about the berry itself—its size, shape, color, texture, core, flavor, seeds; for the markets that he can reach and the prices that he can obtain depend directly upon these factors.

The Ideal Strawberry.

That there may be a clear idea of what characters or qualities should be demanded in a strawberry, the following description, together with certain explanations, is given of what may be considered an *Ideal Strawberry*.

Plant. Large; vigorous; healthy; erect; crowns large and numerous; a good plant maker; very productive. The importance of the first three factors is self-evident. The plant should be erect mainly because plants of such habit are more apt to hold their fruit up off the ground than those of spreading habit. The leaves of erect-growing plants usually afford the flowers better protection from frost than those of plants open and spreading in habit. They can be set a little closer together and the yield for each acre thereby increased. A moderate number of runners is desirable. Varieties that make very few runners are expensive to propagate; too heavy runner formation increases cost of production through requiring more labor to remove them. Crowns should be large and numerous, because in a way they are an index to what yield may be expected. It is needless to say that the more productive the plant the better.

Flower. Perfect; flowering season late. A perfect flowering variety is wanted. Solid blocks can then be planted to a single variety and no thought need be given to the subject of pollination. Furthermore, in harvesting there are not two or three varieties to be kept separate. The flowering season should be relatively late to insure against frost injury.

Fruit stems. The fruit stems of the ideal variety are medium to long, stiff and erect so that the berries are held well up off the ground. This prevents them from becoming soiled, keeps them out of irrigation water, lessens decay during rainy weather, permits of even ripening, and holds them up where they can be most easily picked. To have fruit stems of this type is a much more important matter here than in most of the Eastern states, where mulching with straw or litter of some kind is practiced. There the mulching material serves to keep the fruit clean. Here the plants must keep their own berries clean.

Fruit medium in size, uniform; conic to round, regular; dark red; flesh dark red; very firm; core solid; flavor a rich subacid to acid; quality medium to above; seeds raised and bright yellow. Contrary to what many think, a large-sized strawberry is not the ideal berry. A medium-sized fruit is much to be preferred, as it is easier to pack attractively, usually ships better, and the market will pay as high or a higher price for it than for the very large or very small berry. Uniformity of size is a still more important characteristic. The same price will not be paid for variable as for uniform fruit. If berries are variable in size as they come from the plants, they must be graded in order to reach the best markets. The variety that runs uniform in size reduces the cost of grading to a minimum. Berries that are round, round conic, or conic usually pack better and look better in the package than those of other shapes. A necked berry is not wanted. Irregular berries always sell for second or third-rate prices. The ideal strawberry is dark but bright and glossy red in color. It must be a "live" color. Light red, pink, or salmon-colored berries are not wanted in the general markets, can not be sold to the canneries, and are practically useless from a commercial point of view. The berry should not only be a bright dark red on the outside, but should be a rich deep red all the way through. This is especially important for any variety that is to be used in the canning trade. The flesh should be very firm in

texture and moderately juicy. The core should be solid. These qualities are absolutely essential if the variety is to possess what are termed "shipping qualities" and "canning qualities." For strictly local markets these factors are not quite so important; but broadly speaking, the strawberry industry of the State can develop only as distant markets are reached with the fresh fruit and the canned product. Flavors appeal to different individuals in different ways. Some prefer a sweet strawberry; some acid or subacid berries; to some, a musky flavor is desirable; and by still others, other flavors are sought. For the average market that the Oregon berry must reach, however, a rich subacid to acid berry is wanted. A berry which is simply acid, like the Wilson, is not desired; but one in which the acid is mellowed by enough sugar and solids to give a flavor ranging between subacid and acid is the ideal. Such a berry has a strong strawberry flavor, has character as a fresh fruit, and will possess "quality" when canned. Few people think of the character of the strawberry "seeds" as of any importance. They are, however, very important. If they are depressed so that the fleshy tissue of the fruit projects above them, the berry bruises easily, no matter how firm it may be in texture. On the other hand, if the seeds are raised above the surface of the flesh, they act as a pad and abrasions of the surface are much less likely to occur in picking, grading, packing, and carrying to market. If in addition to being raised the seeds are bright yellow in color they make the red of the berry appear brighter by contrast and add considerably to the attractiveness of the fruit.

Of course it is understood that these characters are given as those of the ideal berry for this and not for some other part of the country. There may be sections where the ideal is quite different. To the extent that varieties have or have not measured up to this ideal they have been regarded as promising or as unpromising in the Station tests. In other words, this has been the standard by which they have been judged.

The Historical Statements.

In connection with the description of each of the strawberry varieties discussed in this paper, a brief historical statement, with citations, has been prepared. No attempt has been made to have these historical statements complete, except for a very few strictly Oregon varieties. The attempt has been, rather, to indicate as nearly as possible some of the main features regarding their history and present status. In nearly all cases many more statements might be made regarding behavior in other sections of the country, but the aim has been simply to give a few references that are typical, to give the key-notes to their records. The purpose in introducing these brief historical statements is that performance here may be compared with performance elsewhere; and from these comparisons to see if there are not some general conclusions that may be drawn regarding strawberry varieties for our conditions.

The Limitations of the Variety Test.

It hardly need be pointed out that there are many limitations to a variety test. The test is made under one set of conditions and its results should be considered strictly applicable only to the same or very similar conditions. In this case, this would mean their limitation to the Willamette Valley. Both the general and the specific recommendations are so few and so conservative, however, that it is believed that they will apply to a much larger part of the State. That any of the varieties discussed will not do as well under moderately favorable conditions in other parts of the State as they are reported doing on the Station grounds is doubtful, for they were tried under unfavorable conditions. That many would prove more vigorous, healthy, and productive at other places in Oregon, there is little doubt. Slight changes in soil, moisture supply, amount of sunshine, etc., often cause corresponding changes in the size and flavor of the berry, and also smaller changes in its color and texture. Most of the varieties discussed here, however, are reported upon unfavorably, not because they fall a little short of the ideal in these particulars, but because they fall far short of it in these or in other respects.

Abington.

Historical. A chance seedling, originating with Lester Blanchard, of Abington, Mass., in 1895 (**48**). At one time considered promising for commercial culture in the northeast (**46, 48**) because of productiveness and fair shipping qualities, but has never become a leading variety.

Description. *Plant* medium to below in both size and vigor; rather low and spreading in habit; fairly healthy; crowns medium or below in number, of good size; a fair plant maker; below medium in yield. *Flower* perfect; flowering season medium to late. *Fruit stems* medium long; fruit held up fairly well. *Fruit* medium to large, rather variable; conic; medium red; flesh medium to light red; medium to rather soft; core solid; flavor slightly subacid, slightly astringent; quality medium to below; seeds even with the surface or slightly depressed.

Discussion. Of no promise.

Albany.

Historical. Mentioned by Newell (**36 [1903-04]**) as a commercial variety in parts of Western Oregon. Probably Wilson, sometimes known as Wilson's Albany, is referred to.

American.

Description. *Plant* small; weak; low and spreading in habit; not healthy; crowns medium in number, small; a very poor plant maker; below medium in yield. *Flower* perfect. *Fruit stems* short; fruit not held up well. *Fruit* medium to large, rather variable; round conic; light red; flesh light red; medium firm; core solid; flavor sweet subacid; quality medium; seeds depressed.

Discussion.—Of no promise.

Anna.

Description. *Plant* below medium in both size and vigor; rather low and spreading in habit; healthy; crowns few in number, below medium in size; a poor plant maker; yield below medium. *Flower* imperfect; flowering season long, early to late. *Fruit stems* short; not holding the fruit up well. *Fruit* below medium in size, quite uniform; broad conic; dark red; flesh medium to dark red; medium to firm; core solid; flavor acid, slightly astringent; quality below medium to poor; seeds even with the surface or slightly depressed.

Discussion. Proved productive the first year that it was under trial but has not yielded satisfactorily since. Of no promise.

Arizona Everbearing.

Historical. Has been one of the leading commercial varieties in portions of the Southwest where great resistance to drought and heat is required (**2**). Of late it has declined some in popularity there (**52**), though it is still considerably grown. Apparently it has not been widely tried in the Eastern strawberry-growing sections.

Description. *Plant* medium in both size and vigor; rather low and semi-spreading in habit; healthy; crowns medium in size, few to medium in number; a good plant maker; below medium to low in yield. *Flower* perfect; flowering season medium. *Fruit stems* short; not holding the fruit up well. *Fruit* medium in size, fairly uniform; conic, slightly compressed; dark red; flesh medium to dark red; firm; core solid; flavor rather acid, slightly astringent; quality below medium; seeds even with the surface or slightly raised.

Discussion. Of no promise.

Aroma.

Historical.—Originated with F. W. Cruse of Kansas (**32**). It has become one of the leading commercial varieties in portions of the Middle West. It is reported as second in importance in Arkansas and third in importance in

Illinois (**1** [**1909**]) in 1909, and as the leading late variety in Kansas in 1911 (**1** [**1911**]). In 1907 it was reported (**4**) as having been a standard in Ohio for the preceding four years.

Description. *Plant* above medium in both size and vigor; semi-spreading in habit; healthy; crowns large, medium ln number; a good plant maker; a little below medium in yield. *Flower* perfect; flowering season medium to late. *Fruit stems* hold the fruit up well. *Fruit* medium to large, rather variable; conic; often somewhat compressed; medium to dark red; flesh medium red; medium to soft; core solid; flavor slightly subacid, rather insipid; quality below medium; seeds even with the surface.

Discussion. Of little promise for this section.

Armstrong.

Description. *Plant* above medium to large; vigorous; fairly erect in habit; healthy; crowns medium in number, large; a medium plant maker; below medium in yield. *Flower* perfect; flowering season medium. *Fruit stems* medium long; fruit not held up well. *Fruit* medium to above, fairly uniform; conic to round conic; medium to bright red; flesh medium to light red; medium to rather soft; core solid; flavor mildly sweet; quality above medium; seeds even with the surface or slightly depressed.

Discussion. Of no promise.

Atlantic.

Historical. The 1884 catalog of M. Crawford Co. states that it was ound as a chance seedling in a cranberry bog in New Jersey. In some of the Atlantic seaboard states it has proved a very good variety with some growers (**41**) but it has not succeeded under average conditions.

Description. *Plant* above medium in both size and vigor; quite compact and erect in habit; healthy; crowns above medium in number, of good size; a medium plant maker; medium to below in yield. *Flower* perfect; flowering season medium to late. *Fruit stems* medium long; fruit held off the ground fairly well. *Fruit* below medium in size, fairly uniform; conic; dark red; flesh dark red; medium to firm; core solid; flavor subacid, slightly astringent; quality medium to below; seeds even with the surface.

Discussion. Of no promise for this section.

Auto.

Historical. Reported as a fairly heavy yielder in Ind. (**38**) and as a fairly satisfactory variety in Va. (**54**).

Description. *Plant* medium to above in both size and vigor; semi-spreading in habit; healthy; crowns few and large; a medium plant maker; low in yield. *Flower* perfect; flowering season medium. *Fruit stems* medium long; berries held up fairly well. *Fruit* medium to above in size, rather variable; conic to broad conic, often compressed; dark red; flesh medium to light red; medium to soft; core solid; flavor slightly sweet, slightly musky; quality medium; seeds slightly raised.

Discussion. Of no promise.

Autumn.

Historical. A seedling of Pan American, originating with Samuel Cooper, Delevan, N. Y. (**1** [**1907**]). Apparently it has not proved very successful in the East.

Description. *Plant* below medium to small; lacking in vigor; low and semi-spreading in habit; not very healthy; crowns fairly numerous, small; a very poor plant maker; medium to low in yield. *Flower* imperfect; flowering season late. *Fruit stems* short; fruit not held up well. *Fruit* below medium, fairly uniform; round conic; dark red; flesh medium red; medium firm; core solid; flavor subacid; quality medium; seeds even with the surface or slightly raised.

Discussion. Produces a light crop in the fall. Of no promise here.

Autumn Belle.

Historical. Originated with Benjamin Worsley, Svensen, Ore.; the result of a cross between Magoon and a wild plant growing in his neighborhood. Has not been widely disseminated and is probably passing out of cultivation.

Description. *Plant* medium or slightly below in size and vigor; compact in habit; healthy; crowns medium in both number and size; a rather poor plant maker; below medium to low in yield. *Flower* perfect; flowering season long, the first flowers coming out early. *Fruit stems* short; fruit held up fairly well. *Fruit* medium to below in size, quite uniform; broad conic, often compressed; medium to dark red; flesh medium to dark red; medium to rather soft; core solid; flavor mildly sweet, slightly musky; quality medium; seeds even with the surface or slightly raised.

Discussion. Probably of little value, though Mr. Worsley states that it produces a profitable fall crop for him in a light sandy soil and Mr. Wolfer, of Central Point, regards it as a satisfactory fall cropper in the Rogue River Valley.

Burt.

Synonym. Burt's Seedling (**28**).

Historical. Probably the same as Captain Jack (**28**). A variety under this name is mentioned by Coote (**9**) as being grown in Oregon.

Banquet.

Historical. Mentioned by Coote (**9**) as being grown in Oregon. Claimed to be a cross between Miner and the wild F. virginiana, originating in N. Y. (**1** [**1891**]).

Barrymore.

Historical. The 1911 catalog of M. Crawford Co. states that it originated with H. L. Crane of Westwood, Mass. Has not proved satisfactory at the Ohio Exp. Sta. (**25**).

Description. *Plant* below medium in both size and vigor; rather spreading; healthy; a good plant maker; crowns rather few; of medium size; low in yield. *Flower* perfect; flowering season rather late. *Fruit stems* short; fruit not held up well. *Fruit* medium in size, fairly uniform; roundish to broad conic; dark red; flesh medium red; medium to rather soft; core solid or half hollow; flavor mild subacid to neutral; quality medium; seeds even with the surface or slightly raised.

Discussion. Of no promise.

Beaver.

Synonym. Beavers (?) (**4**, **46**).

Historical. Evidently there are two varieties going under this name. Taylor (**47**) states that it originated near Dayton, Ohio, and reports it as doing unsatisfactorily in New York. Taft (**46**) mentions the "Beavers" as a variety of Western origin. E. L. Wolfer, of Eagle Point, Ore., in a letter dated April 10, 1911, states that the "Beaver" originated with C. E. Wightman, Mt. Vernon, Wash. It is not certain which of the two varieties has been under test at this Station, though probably it is the western variety.

Description. *Plant* below medium to small; lacking in vigor; low and spreading in habit; moderately healthy; crowns few, small; a rather poor plant maker; low in yield. *Flowers* imperfect; flowering season medium to late. *Fruit stems* medium in length; fruit held up fairly well. *Fruit* medium to below in size; fairly uniform; broad conic; dark red; flesh dark red; medium to firm; core solid; flavor somewhat acid and somewhat astringent; quality below medium; seeds even with the surface.

Discussion. Of no promise.

Bederwood.

Synonyms. Beder Wood (**26**). Racster (**32**).

Historical. Supposed to have originated with Mr. Beder Wood, Moline, Ill., from seed sown in 1881 (**32**). In spite of the almost universal complaint that this berry is soft in texture, it has held its place among the leaders in many sections, and largely because of its yielding abilities. For instance, in 1894 Gurney (**26**) reported it as the most satisfactory variety in the Missouri Valley; Paddock in 1896 (**39**) mentioned it as one of New York's best mid-season varieties; and as late as 1909 Longyear (**31**) reported it as the leading variety in certain sections of Colorado. Other references might be given to show its wide adaptation in sections east of the Rocky Mountains. It has been, and still remains, one of the dominant varieties in the American strawberry industry.

Description. *Plant* large to very large; very vigorous; erect in habit; healthy; crowns medium in size, numerous; a good plant maker; very heavy in yield. *Flower* perfect; flowering season long, the first flowers appearing early. *Fruit stems* medium long; fruit held up well. *Fruit* medium to a little below in size, uniform; round to round conic, with a suggestion of a neck; medium to light red; flesh light red; soft; core solid; flavor slightly acid; quality medium; seeds slightly depressed.

Discussion. Though this variety apparently does as well here as in many other sections, it is not to be recommended. It is grown to a very limited extent in some parts of the State, but is too soft and too poorly colored to meet the requirements of a commercial variety in the Northwest. About the only purpose for which it can be used is the manufacture of strawberry pulp for the confectionery trade and there are other varieties that are better for this. It furnishes a good illustration of the fact that the estimate placed upon a variety in the eastern states is no indication of what it is worth here.

Beidler.

Historical. Originated with M. T. Thompson, Rio Vista, Va., and introduced in 1905 (**47**). It has been reported upon favorably (**46**) in at least one state, Mich., especially for heavy soils. Other than that, reports do not seem to be so favorable (**38, 47**).

Description. *Plant* medium to slightly above in size and vigor; rather low and spreading in habit; healthy; crowns few to medium, medium to above in size; a good plant maker; medium to below in yield. *Flower* perfect; flowering season medium to early. *Fruit stems* medium to short; not holding the berries up well. *Fruit* medium to large, variable; conic to broad conic, often compressed; medium to dark red; flesh medium red; medium to soft; core solid; flavor mild subacid, slightly musky; quality medium to below; seeds even with the surface.

Discussion. Of no promise.

Belle.

Historical. At least two varieties have been sent out under this name, one originating with J. B. Moore, Concord, Mass., in the sixties or early seventies (**34** [**1875**]); and one sent out by M. Crawford Co. in 1893 as their "51." It is the latter variety that has been under trial at this Station.

Description. *Plant* medium to below in both size and vigor; semi-erect in habit; healthy; crowns below medium in both size and number; a fair plant maker; variable in yield, though for the most part unsatisfactory. *Flower* perfect; flowering season medium. *Fruit stems* short; fruit not held up well. *Fruit* below medium, fairly uniform; conic; dark red; flesh dark red; medium firm; core solid; flavor slightly acid, rather astringent; quality below medium; seeds even with the surface.

Discussion. Of no promise.

Belt.

Synonym. William Belt (**1** [**1909**]).

Historical. Originated with William Belt, of Ohio (**53**). Has given fairly satisfactory results in a number of sections; e. g., N. Y. (**39**), Ind. (**38**), Ohio (**20**), Ont. (**53**), Col. (**31**).

Description. *Plant* below medium in both size and vigor; rather spreading; moderately healthy; crowns medium to below medium in both number and size; a rather poor plant maker; below medium in yield. *Flower* perfect; flowering season medium. *Fruit* above medium; conic, compressed; medium red; flesh light red; medium firm; core half-hollow; flavor subacid; quality medium; seeds even with the surface or depressed.

Discussion. Of no promise.

Berlin.

Historical. A seedling of Haverland, originating in Ind. (1912 Cat. Flansburgh & Son).

Description. *Plant* a little below medium in both size and vigor; rather spreading; fairly healthy; crowns medium to below in size, medium in number; a fair plant maker; medium in yield. *Flower* perfect; flowering season medium to late. *Fruit stems* medium long, fruit held up fairly well. *Fruit* medium in size, quite uniform; conic; medium to dark red; flesh light red; medium firm; core solid; flavor sweet subacid, slightly musky; quality medium; seeds raised.

Discussion. Of no promise.

Big Bob.

Historical. Mentioned as having been grown in Western Oregon (**36** [**1897-98**]). Apparently it never proved a success here. An eastern variety.

Bismark.

Historical. A seedling of Bubach crossed with Van Deman, originating with J. C. Bauer, Judsonia, Ark. (**32**). Though it has never become a dominant commercial variety, it has been successfully grown in some of the eastern sections. (**10, 53**).

Description. *Plant* below medium in size and vigor; low and spreading in habit; quite healthy; crowns few, small; a fair plant maker; below medium to low in yield. *Flower* perfect; flowering season medium. *Fruit* medium or below in size, fairly uniform; broad conic; light red; flesh light red; medium soft; core solid; flavor subacid; quality medium to below; seeds partly raised.

Discussion. Of no promise.

Black Beauty.

Historical. Recently reported upon favorably in Ind. (**38**).

Description. *Plant* above medium in both size and vigor, though somewhat variable; erect-spreading; healthy; crowns below medium in number, above medium in size; a very good plant maker; below medium in yield. *Flower* imperfect; flowering season medium to late. *Fruit stems* medium long; fruit held up fairly well. *Fruit* medium in size, uniform; round to round conic, often slightly necked; dark red; flesh dark red; medium to rather soft; core solid; flavor sweet subacid; quality good; seeds even with the surface.

Discussion. Of no promise.

Blizzard Belt.

Historical. Introduced in 1910 by the Gardner Nursery Co., of Iowa (1912 Catalog of Flansburgh & Son).

Description. *Plant* below medium in both size and vigor; quite erect; crowns medium in number, below medium to small in size; quite healthy; a fair to poor plant maker; below medium in yield. *Flower* perfect; flowering season medium to late. *Fruit stems* short; fruit held up quite well. *Fruit* below medium in size, uniform; broad conic; dark red; flesh medium to dark

red; medium to rather soft; core solid; flavor rather acid; quality medium or below; seeds even with the surface.

Discussion. Of no promise.

Bomba.

Historical. A seedling of Crimson Cluster, originating at Parry, N. J. (**32**). Recommended by Coote (**9**) in 1891 for the Willamette Valley.

Bountiful.

Historical. A seedling of Glen Mary (1912 Catalog Flansburgh & Son). Has apparently given fairly satisfactory results in Va. (**54**) and Ohio (**25**), though not in Ind. (**38**).

Description. *Plant* medium to below in both size and vigor; semi-spreading; crowns few, rather large; quite healthy; a fair plant maker; below medium in yield. *Flower* perfect; flowering season medium to late. *Fruit stems* short; not holding fruit up well. *Fruit* below to above medium, rather variable; broad conic; dark red; flesh dark red; medium to rather soft; core solid; flavor mild subacid; quality medium; seeds even with surface.

Discussion. Of no promise.

Brandywine.

Historical. Originated with T. T. Ingram, of Pa. in 1889 and is supposed to be the result of a cross between Glendale and Cumberland (**32**). It has been a standard variety in a number of the Northeastern states (**44, 46, 10**) and in Eastern Canada (**32**); and has also been grown extensively in Southern Cal. (**52**).

Description. *Plant* below medium in both size and vigor; compact in growth; quite healthy; a fair plant maker; below medium in yield. *Flower* perfect; flowering season medium to early. *Fruit stems* rather short; fruit not held up well. *Friut* medium in size, rather variable; conic; medium red; flesh light red; medium firm; core solid; flavor subacid; quality medium; seeds even with the surface.

Discussion. Of no promise.

Brunette.

Historical. Originated with Granville Cowing of Ind. and introduced in 1895 (**32**). It is a variety that has been recommended more for the amateur than for the commercial grower (**45, 19**).

Description. *Plant* small; lacking in vigor; semi-spreading; fairly healthy; crowns few, medium sized; a poor plant maker; very low in yield. *Fruit* medium in size, fairly uniform; roundish; dark red; flesh medium red; medium firm; core solid; flavor sweetish subacid; quality good; seeds somewhat depressed.

Discussion. Of no promise.

Bubach.

Synonyms. Bubach No. 5 (**1** [**1901**]); Bubach's No. 5 (**1** [**1909**]); Buhaw —probably erroneously—(**9**).

Historical. Originated with J. G. Bubach, Princeton, Ill. (**32**). This has been one of the dominant strawberry varieties of the eastern states. McCoun asserts (**32**) that it has been a leader in eastern Canada for 20 years. Corbett (**10**) recommends it for most of the country east of the Mississippi and north of the Ohio rivers. It has also proved a leader in Mo. (**35** [**1890**]); and has been mentioned as being considerably grown in Western Ore. (**36** [**1897-8**]).

Description. *Plant* below medium in size; moderately vigorous; rather low and spreading; quite healthy; crowns below medium in size and number; a fair to poor plant maker; below medium in yield. *Flower* imperfect; flowering season medium to late. *Fruit stems* rather short; fruit not held up well. *Fruit*

medium to below uniform; roundish to oblate; light red; flesh light red; medium firm; core solid; flavor subacid; quality medium; seeds even with the surface.

Discussion. Of no promise.

Buster.

Historical. Originated with a Mr. Stone in Ill. (**53**). The result of a cross between Bubach and Sharpless (**32**). It apparently has succeeded in some of the eastern (**46, 4**) and middle western (**1** [**1911**]) states and eastern Canada (**32**).

Description. *Plant* above medium to large; vigorous; quite erect; healthy; crowns medium in size, medium or above in number; a good plant maker; medium to above in yield. *Flowers* perfect; flowering season medium to late. *Fruit stems* rather short; fruit held up well. *Fruit* medium to below, fairly uniform; round conic, slightly necked; medium to light red; flesh medium to light red; medium to rather soft; core solid or sometimes hollow; flavor mild subacid to mildly sweet; quality medium; seeds even with surface.

Discussion. Of no promise.

Cameron.

Synonyms. Camerons (**38**); Cameron's Early.

Description. *Plant* above medium in both size and vigor; quite erect; crowns medium in both size and number; quite healthy; a good plant maker; low in yield. *Flower* perfect; flowering season medium to late. *Fruit stems* medium to short; fruit not held up well. *Fruit* medium to below in size, uniform; conic to broad conic; medium red; flesh medium to light red; very soft; core usually solid; flavor sweet to neutral; quality medium to below; seeds even with the surface to slightly depressed.

Discussion. Of no promise.

Captain Jack.

Synonyms. Burt (**35** [**1890**]); Burt's Seedling (?) (**28**).

Historical. A seedling of Wilson (**43**), originating with S. Miller, of Bluffton, Mo. (**35** [**1883**]). More attention seems to have been given this variety in the Middle West than elsewhere, though it has been reported upon favorably in N. Y. (**28**). It seems to have done especially well in Mo. (**35** [**1883**]) and Kan. (**35** [**1890**]). It has also been recently reported as one of the leading varieties about Denver, Col. (**31**).

Description. *Plant* medium to below in both size and vigor; rather erect; quite healthy; crowns medium in number, medium or below in size; a rather poor plant maker; medium to below in yield. *Flower* perfect; flowering season medium to late. *Fruit stems* rather short; fruit not held up well. *Fruit* medium to below in size, rather variable; broad conic, regular; dark red; flesh medium red; medium firm; core solid; flavor mildly subacid to mildly sweet, slightly musky and slightly astringent; quality medium; seeds partly raised.

Discussion. Of no promise.

Cardinal.

Historical. A chance seedling originating with a Mr. Streator in 1896 and thought to be of Warfield descent (**48**). It has given widely varying results at several of the eastern Experiment Stations. Taylor (**48**) reports it promising in N. Y. and Green (**24**) promising in Ohio. On the other hand Ballou (**3**) three years later finds it disappointing in Ohio.

Description. *Plant* medium to below in both size and vigor; healthy; a little spreading in habit; crowns few, medium in size; a fair plant maker; below medium to low in yield. *Flower* imperfect or practically so; flowering season medium to late. *Fruit stems* short; fruit held up well. *Fruit* medium to above, fairly uniform; broad conic, often compressed; dark red; flesh medium

red; medium firm; core solid; flavor mild subacid; quality medium; seeds half raised.

Discussion. Of no promise.

Challenge.

Historical. Originated with J. R. Peck, of Breckenridge, Mo., in the early nineties (1902 Catalog M. Crawford Co.). Reported as promising in Ohio (**22, 24**) but rather unpromising in N. Y. (**47**).

Description. *Plant* below medium in both size and vigor; low growing, but compact; crowns medium in number, rather small; a rather poor plant maker; below medium in yield. *Flower* perfect; flowering season medium to early. *Fruit* medium to above in size; dark red; flesh light red; rather soft; flavor subacid; quality medium; seeds even with the surface.

Discussion. Of no promise.

Chellie.

Description. *Plant* very small; weak; low, spreading in habit; not healthy; crowns few, small; a very poor plant maker; very low in yield. *Fruit* below medium in size; conic; dull red; flesh medium red; soft; flavor astringent; quality poor; seeds raised.

Discussion. Of no value.

Chesapeake.

Historical. Originated with J. W. Parks of Md. (1911 Catalog M. Crawford Co.). Has given promising results in trials made at the Experiment Stations of N. Y. (**48**), Ohio (**4**), Mich. (**46**), Va. (**54**), and Col. (**31**).

Description. *Plant* small; weak; low and compact; not healthy; crowns few, small; a very poor plant maker; very low in yield. *Flower* perfect. *Fruit* medium in size; round conic; light red; flesh light red; firm; core solid; flavor astringent; quality poor; seeds slightly raised.

Discussion. Of no promise.

Chipman.

Historical. Originated as a chance seedling with a Mr. Chipman, of Lincoln, Del., in 1901, in a plantation of Bubach and Tennessee Prolific (**48**). It has proved unsatisfactory in Ohio (**25**); partly satisfactory in Va. (**54**).

Description. *Plant* below medium in size and vigor; low, spreading in habit; healthy; crowns medium in size, medium or below in number; a fair plant maker; low in yield. *Flower* perfect; flowering season medium to late. *Fruit stems* medium long; fruit held up medium well. *Fruit* medium to below in size, quite uniform; ovate conic, regular, slightly necked; medium to dark red; flesh light red; rather soft; core solid; flavor mildly sweet; quality medium; seeds even with the surface.

Discussion. Of no promise.

Clara.

Description. *Plant* medium in both size and vigor; rather spreading; healthy; crowns medium to below in size, medium in number; a good plant maker; medium in yield. *Flower* perfect; flowering season medium to late. *Fruit stems* short; fruit not held up well. *Fruit* medium to a little below, fairly uniform; broad conic; medium to dark red; flesh medium red; medium firm; core solid; flavor mildly sweet; quality medium; seeds slightly raised.

Discussion. Of no promise.

Clark.

Synonyms. Clark's Seedling (**36 [1909-10]**); Clark's Early (**36 [1909-10]**); Early Idaho (**5**); Hood River (**10**).

Historical. Originated with Mr. Fred Clark, near Portland, Ore., in

the early eighties or late seventies (**36** [**1909-10**]); supposed to be a seedling of Wilson (**36** [**1889-90**]). Soon after its introduction it became the leading variety in the State. It is probably to be regarded as our leading variety today. Some sections, like the Hood River Valley, grow it almost exclusively. Though it has been tried in a number of the eastern states it has failed to give satisfaction there. Beach (**5, 6**) reports it unproductive in N. Y.; Craig (**11**) finds the same fault with it in eastern Canada, and Longyear, (**31**) in Col.

Description. *Plant* above medium in both size and vigor; erect; healthy; crowns medium in size, above medium in number; a moderately good plant maker; medium to below in yield. *Flower* perfect; flowering season medium. *Fruit stems* medium long, stiff and erect, holding the fruit up well. *Fruit* medium or a little below in size, uniform; round to round conic, regular; dark, rich red; flesh dark red; very firm; core solid; flavor acid; quality medium to below; seeds bright yellow and raised, their contrast with the dark red of the flesh making the fruit very attractive.

Discussion. Clark possesses the best shipping quality of any strawberry grown in the Northwest, if not in the whole country. It is mainly because of its excellent shipping quality that it is so largely grown. This enables it to be placed upon distant markets in prime condition and to sell for higher prices than softer berries raised within a few miles of these markets. The larger part of the Clark strawberry crop is marketed east of the Rocky Mountains —occasional carloads going to the Atlantic seaboard. It is also the best canning variety raised in the State. It holds its shape and color well in the can and its acidity gives it quality as a canned fruit. The one drawback to the culture of this variety is its lack of productiveness. Good growers occasionally obtain 200 crates an acre, though 100 to 125 is nearer the average. Yields of less than 100 crates to the acre are not infrequent. Notwithstanding these low yields it is doubtful if at present there is a more profitable variety to grow in Oregon. The prices obtained for it average at least twice those paid for the ordinary varieties. It is believed that many who are growing other varieties would do well to devote perhaps a smaller acreage to this variety and through intensive methods of culture increase the present average yields obtained with it. It seems to prefer soils of the lighter types.

Climax.

Historical. Originated with H. W. Graham, Wetipquin, Md., (**47**); supposed to be a seedling of Bubach crossed with Hoffman (1910 Catalog of W. N. Scarff). In at least three eastern states—N. Y. (**47**), Mich. (**46**), and Va. (**54**)—it has been reported promising as an early berry.

Description. *Plant* medium in both size and vigor; rather spreading; quite healthy; crowns medium in size and number; a good plant maker; medium to below in yield. *Flower* perfect; flowering season medium. *Fruit* medium in size, fairly uniform; rather oblate; dark red; medium firm; core solid; flavor subacid; quality medium; seeds even with the surface.

Discussion. Of no promise.

Cloud.

Historical. Mentioned by Coote (**9**) as giving unsatisfactory results at this Station.

Clyde.

Historical. A seedling of Cyclone, originating about 1890 with a Dr. Stamen, of Kan. (**53**). At one time this variety was quite generally grown in the northeastern and central states and it is still a standard in some sections. Among those states where it has been recommended for commercial culture at one time or another are Mich. (**44, 46**), Ohio (**20**), Wis. (**16**), and Kan. (**1-[1911]**).

Description. *Plant* above medium in both size and vigor; rather spreading in habit; quite healthy; crowns medium or above in number, of good size;

a moderate plant maker; medium to below in yield. *Flower* perfect; flowering season medium to early. *Fruit stems* medium to short; not holding fruit up well. *Fruit* below medium in size, quite uniform; round conic, regular; medium to dark red; flesh medium to light red; medium firm; core solid; flavor subacid; quality medium; seeds even with the surface.

Discussion. Clyde has been far from satisfactory in the Station tests. Mr. E. L. Wolfer, who has grown it for a number of years in the Rogue River Valley, states that it does very satisfactorily for him. With him, it shows a marked tendency toward producing a second crop in the fall. It is possible that it may be of value in limited sections of the State, but on the whole it promises little.

Columbia.

Historical. Said to have originated with Wild Bros., of Sarcoxie, Mo., and to be a cross between Warfield and Gandy (1908 Catalog D. McNallie Co.). Reported as very promising in N. Y. (**48**) and Ind. (**38**).

Description. *Plant* above medium in both size and vigor; semi-erect; healthy; crowns medium in both size and number; a good plant maker; medium in yield. *Flower* imperfect; flowering season rather late. *Fruit stems* short; but fruit held up fairly well. *Fruit* medium to large, variable; conic, compressed; dark red; flesh medium red; medium to firm; core hollow; flavor mild subacid to neutral; quality medium to above; seeds raised.

Discussion. Not very promising, but possibly worthy of a limited trial.

Commander.

Historical. A foreign variety, the result of a cross between British Queen and President (1896 Catalog M. Crawford Co.). Has been reported upon unfavorably by N. Y. (**48**), Ohio (**24**) and Va. (**54**).

Description. *Plant* below medium in both size and vigor; semi-spreading in habit; only moderately healthy; crowns few in number, of medium size; a medium plant maker; in the Station tests yielded well the first year and then proved an almost complete failure later. *Flower* perfect. *Fruit stems* medium long; fruit not held up well. *Fruit* medium in size; round conic; dark red; soft; core solid; flavor sweet subacid; quality medium; seeds depressed.

Discussion. Of no promise.

Commonwealth.

Historical. Originated in 1902 with W. H. Monroe, Commonwealth, Mass., (**47**). Has been reported upon unfavorably in N. Y. (**47**).

Description. *Plant* small; lacking in vigor; semi-spreading; not very healthy; crowns few, rather small; a fair plant maker; below medium in yield. *Flower* perfect. *Fruit stems* medium long; fruit not held up well. *Fruit* above medium in size; conic; bright red; medium firm; flavor mildly sweet to neutral; quality medium; seeds slightly raised.

Discussion. Of no promise.

Cooper.

Description. *Plant* small; weak; fairly healthy; low, spreading; crowns medium in number, small; a poor plant maker; medium in yield the first season but has been unsatisfactory since. *Flower* perfect. *Fruit* medium in size; conic; dark red; medium firm; flavor acid; quality medium or below; seeds depressed.

Discussion. Of no promise.

Corsican.

Synonyms. Armstrong, German Seedling, Morgan's Favorite (1910 Catalog L. J. Farmer).

Description. *Plant* above medium in both size and vigor; quite erect;

healthy; a good plant maker; crowns medium in number and size; medium to below in yield. *Flower* perfect; flowering season medium. *Fruit stems* medium long; fruit held up fairly well. *Fruit* medium to below, uniform; round conic to ovate, often slightly necked; medium to dark red; flesh medium to light red; medium firm; core solid; flavor sweet, slightly musky; quality above medium; seeds slightly raised.

Discussion. Of no promise.

Crescent.

Synonym. Crescent Seedling (**1** [**1909**]).

Historical. Originated with Wm. Parmalee, New Haven, Conn., in 1868 (**32**). Has been one of the most prominent strawberry varieties in America and has been grown in large quantities in practically all the strawberry-producing sections east of the Rocky Mountains (**10, 51** [**1890**]). Its color and texture have always been against it, but its great adaptability and productiveness have made it a favorite. It used to be grown to some extent in Western Oregon (**36** [**1897-98**]).

Description. *Plant* medium or below in both size and vigor; rather spreading; healthy; crowns medium in number or above, medium in size; a fair plant maker; above medium in yield. *Flower* imperfect; flowering season medium. *Fruit stems* medium long; fruit held up fairly well. *Fruit* below medium to small, uniform; conic to round conic; medium red; flesh light red to pink; soft; core solid; flavor rather acid; quality below medium; seeds even with the surface or slightly raised.

Discussion. Though fairly productive, the berry does not meet the requirements of a good strawberry here. Of no promise.

Crimson Cluster.

Historical. Of English origin (**12**). Reported as of little value in N. Y. (**28**). Apparently not extensively tried in the U. S.

Description. *Plant* medium or above in size and vigor; upright; healthy; a fair plant maker; low in yield. *Flower* perfect. *Fruit* medium to above; conic; light red; flesh light red; medium firm; flavor acid; quality medium; seeds slightly raised.

Discussion. Of no promise.

Dicky.

Synonym. Dickey (**25**).

Historical. A seedling of Marshall and Sample, originating with J. D. Gowing, N. Reading, Mass., and introduced in 1908 (**49**). New York (**49**), Ohio (**25**), and Va. (**54**) report it fairly productive, but inferior in fruit characters.

Description. *Plant* medium in both size and vigor; fairly erect; moderately healthy; crowns medium in number and size; a poor plant maker; above medium in yield the first season under trial but very unsatisfactory after that. *Flower* perfect; flowering season medium. *Fruit stems* medium to short; fruit not held up well. *Fruit* medium to below, fairly uniform; conic; medium red; flesh light red; rather soft; core solid; flavor subacid; quality medium; seeds slightly raised.

Discussion. Of no promise.

Dornan.

Synonym. Uncle Jim (**48**).

Historical. A chance seedling originating with J. F. Dornan, of Glen, Mich., and introduced in 1901 (**48**). Apparently it has done fairly well in trials made in Ohio (**22**) and Ind. (**38**).

Description. *Plant* above medium in size and vigor; semi-erect; healthy; crowns medium in number, above medium in size; medium in yield. *Flower* perfect; flowering season medium. *Fruit stems* medium long; but fruit not

held up well. *Fruit* medium to large, rather variable; broad conic; medium red; flesh medium to light red; rather soft; core solid; flavor mildly sweet; quality above medium; seeds even with the surface.

Discussion. Mr. E. L. Wolfer, who has given it a thorough trial in the Rogue River Valley, has finally discarded it. Of little promise.

Dunlap.

Synonym. Senator Dunlap (1 [1909]).

Historical. Originated about 1890 with J. R. Reasoner, Urbana, Ill.; thought to be a seedling of Warfield (48). At one time or another this has been one of the leading commercial varieties in the northeastern and middle western states. Among those in which it has succeeded may be mentioned Mass. (1 [1911]), N. Y. (48), Ohio (4), Ill. (1 [1911]), Kan. (1 [1911]), Col. (31), Ind. (38).

Description. *Plant* a little above medium in both size and vigor; semi-spreading; healthy; crowns medium in size, above medium in number; a very good plant maker; medium in yield. *Flower* perfect; flowering season medium to early. *Fruit stems* medium to short; fruit not held up well. *Fruit* medium to slightly below in size, fairly uniform; conic; dark red; flesh medium to dark red; medium firm; core solid; flavor sweet subacid; quality medium; seeds even with the surface.

Discussion. This variety has occasionally been reported as doing fairly well in Southern Oregon, but it cannot be generally recommended for this State.

Dutter.

Historical. At one time recommended for the Willamette Valley (9), but evidently has never been grown here to any extent.

Earliest.

Historical. A seedling of Michael Early (40). Has proved unproductive in N. Y. (41) and Mich. (45).

Form of the leading varieties of strawberries in Oregon. Upper left, Magoon. Upper right, Oregon. Lower left, Wilson. Lower right, Clark.

Description. *Plant* above medium in both size and vigor; semi-spreading; healthy; crowns above medium in both size and number; a good plant maker; low in yield. *Flower* perfect; flowering season medium to early. *Fruit stems* short; not holding fruit up well. *Fruit* below medium to small; round to conic, slightly necked; medium to dark red; flesh light red; rather soft; core solid; flavor slightly sweet, slightly musky; quality medium to below; seeds slightly raised.

Discussion. Of no promise.

Early Bird.

Historical. Reported as being unsatisfactory in Mich. (**45**).

Description. *Plant* small; lacking in vigor; low, spreading; fairly healthy; crowns few, of medium size; a fair plant maker; below medium to low in yield. *Flower* imperfect; flowering season rather early. *Fruit stems* medium to short; fruit held up medium well. *Fruit* below medium to small; broad conic; medium red; flesh medium red; medium to rather soft; core solid; flavor rather insipid; quality below medium; seeds even with the surface.

Discussion.—Of no promise.

Early Beauty.

Description. *Plant* above medium in both size and vigor; quite erect; healthy; crowns medium in number, medium or above in size; a good plant maker; below medium in yield. *Flower* perfect; flowering season medium to early. *Fruit stems* medium long; but fruit not held up well. *Fruit* below to above medium, rather variable; round conic, regular; medium to dark red; flesh medium to light red; medium to soft; core solid; flavor mildly sweet; quality medium to good; seeds even with the surface.

Discussion. Of no promise.

Early Hathaway.

Historical. A seedling of Wilson crossed with Hoffman, originating in Ark. (1905 Cat. M. Crawford Co.)

Description. *Plant* above medium in size and vigor; erect; healthy; crowns medium in number and size; a fair plant maker; medium to below in yield. *Flower* perfect; flowering season medium to early. *Fruit stems* medium long; fruit held up fairly well. *Fruit* below medium, fairly uniform; round conic, regular; medium to dark red; flesh medium red; medium firm; core solid; flavor sweet subacid, slightly astringent; quality medium; seeds slightly depressed.

Discussion. Of no promise.

Eleanor.

Historical. Unproductive and unsatisfactory in tests made at the N. Y. (**40**) and Ohio (**20**) Experiment Stations, but has given some promise as an early variety in eastern Canada (**32, 53**).

Description. *Plant* medium or a little above in both size and vigor; rather spreading; healthy; crowns below medium in number, medium to above in size; a fair plant maker; below medium in yield. *Flower* perfect; flowering season medium to early. *Fruit* below medium, quite uniform; roundish; light red; flesh light red; rather soft; flavor subacid; quality below medium; seeds even with surface or slightly raised.

Discussion. Of no promise.

Elma.

Historical. Originated in 1900 with J. H. Black, Son & Co., Hightstown, N. J.; the result of a cross of Robbie and Nettie, crossed with Joe (**48**). Though unproductive in N. Y. (**48**), it has given some promise in Ohio (**4**) and Mich. (**46**).

Description. *Plant* below medium in both size and vigor; semi-spreading;

fairly healthy; crowns few, medium in size; a poor plant maker; low in yield. *Fruit* below medium in size; round conic; bright red; flesh medium to light red; medium firm; core solid; flavor acid; quality below medium; seeds somewhat raised.

Discussion. Of no promise.

Enormous.

Historical. A seedling of Crescent, originating with B. O. Curtis, of Ill. (**32**). Has given fairly satisfactory results in Ohio (**20**), Wis. (**16**), and eastern Canada (**32**); but reports from Mich. (**46**) are less satisfactory.

Description. *Plant* below medium in both size and vigor; spreading; moderately healthy; crowns medium in number, rather small; a poor plant maker; below medium in yield. *Flower* semi-perfect; flowering season medium to late. *Fruit* below medium in size; broad conic; medium red; flesh light red; rather soft; core solid; flavor subacid; quality below medium; seeds even with the surface or slightly raised.

Discussion. Of no promise.

Ettersburg No. 71.

Historical. Originated with Albert F. Etter, Briceland, Cal.

Description. *Plant* above medium in both size and vigor; erect to erect-spreading; healthy; crowns numerous, medium to below in size; a good plant maker; very heavy in yield. *Flower* imperfect; flowering season late to very late. *Fruit stems* medium long; fruit held up well. *Fruit* medium to above in size, fairly uniform; roundish oblate, regular; light red; flesh light red to white; medium firm; core solid; flavor subacid, rather insipid; quality below medium; seeds even with the surface or slightly depressed.

Discussion. Unpromising because of its inferior quality.

Ettersburg No. 75.

Historical. "A. Michel's Early x Rose Ettersburg-Cape Mendocino Beach" cross, originating with Albert F. Etter, Briceland, Cal. (Catalog A. F. Etter.)

Description. *Plant* very large; very vigorous; erect to erect-spreading; moderately healthy; crowns numerous, medium in size; a good plant maker; medium in yield. *Flower* imperfect; flowering season late to very late. *Fruit stems* long; fruit held up well. *Fruit* below medium in size, uniform; conic to broad conic; medium to dark red; flesh medium red; medium to firm; core solid; flavor mildly sweet; quality medium to below; seeds slightly raised.

Discussion. Not very promising.

Ettersburg No. 80.

Historical. "A seedling of Sharpless x Parry of the third generation was crossed with the Peruvian Beach, or sand strawberry, producing Rose Ettersburg. Rose Ettersburg was crossed with *Californica*, our native wood strawberry, producing No. 3, a berry of no value. No. 3 was crossed with a hybrid from Rose Ettersburg and the Cape Mendocino Beach strawberry." Ettersburg No. 80 was one of the resulting seedlings. (Catalog A. F. Etter.)

Description. *Plant* large to very large; vigorous to very vigorous; erect-spreading; fairly healthy; crowns numerous, medium in size; a good plant maker; very heavy in yield. *Flower* perfect; flowering season very late. *Fruit stems* medium to long; fruit held up well. *Fruit* medium to above in size, fairly uniform; roundish to broad conic; dark red; flesh medium red; firm; core solid; flavor sweet subacid; quality medium; seeds even with the surface.

Discussion. This variety is worthy of trial on a limited scale.

Ettersburg No. 89.

Historical. "A hybrid Marshall x Cape Mendocino Beach," originating with A. F. Etter, of Briceland, Cal. (Catalog A. F. Etter.)

Description. *Plant* large to very large; very vigorous; erect-spreading; healthy; crowns numerous, medium in size; a fair plant maker; very heavy in yield. *Flower* perfect; flowering season very late. *Fruit stems* medium to long; fruit held up well. *Fruit* medium to a little above in size, uniform; broad conic, regular; dark red; flesh dark red; medium to rather firm; core solid; flavor subacid, insipid; quality below medium to poor; seeds even with the surface, bright yellow.

Discussion. Unpromising because of inferior quality.

Ettersburg No. 94.

Historical. "A White Alpine crossed with a hybrid Rose Ettersburg-*Californica*," originating with A. F. Etter, Briceland, Cal. (Catalog of A. F. Etter.)

Description. *Plant* above medium to large; vigorous; erect to erect-spreading; healthy; crowns numerous, medium in size; a fair plant maker; very heavy in yield. *Flower* imperfect; flowering season very late. *Fruit stems* long; fruit held up well. *Fruit* medium in size, uniform; conic; very dark red; flesh dark red; firm; core solid; flavor rather acid, slightly astringent; quality below medium to poor; seeds slightly raised.

Discussion. Unpromising because of inferior quality.

Ettersburg No. 121.

Historical. "A hybrid of the wild Alpine crossed with the Cape Mendocino Beach strawberry," originating with A. F. Etter, Briceland, Cal. (Catalog of A. F. Etter.)

Description. *Plant* very large; very vigorous; erect; somewhat susceptible to leaf spot, but vigorous in spite of this fault; crowns very numerous, medium in size; a good plant maker; heavy to very heavy in yield. *Flower* perfect; flowering season very late. *Fruit stems* very long; fruit held up very well. *Fruit* below medium in size, uniform; roundish, very slightly necked, regular; dark red; flesh dark red; very firm; core solid; flavor slightly subacid to sweet, with a slight peculiar after-taste; quality good; seeds even with the surface.

Discussion. This variety is well worthy of trial on a limited scale. It seems to possess the qualities that go to make a good canning berry. Its main drawback is its small size; but it is quite possible that under more favorable conditions than those of the Station test it would average a little larger.

Excelsior.

Historical. A seedling of Hoffman, crossed with Wilson, originating with Louis Hubach, Judsonia, Ark., about 1890 (**48**). The acidity of this variety has always occasioned unfavorable criticism, but it has nevertheless been grown in many places as an early market variety. There are favorable reports from Ohio (**22, 24**), Mich. (**44**), Ark. (**1, [1909, 1911]**), Va. (**54**), Ont. (**53**). Reports from N. Y. (**28, 48**) are less favorable. It has also been grown extensively in some parts of Cal. (**52**).

Description. *Plant* above medium in both size and vigor; semi-erect; healthy; crowns medium in number, above medium in size; a good plant maker; medium in yield. *Flower* perfect; flowering season medium to early. *Fruit stems* fairly long; fruit held up fairly well. *Fruit* medium to above, fairly uniform; round conic, slightly necked; medium red; flesh light red; medium firm; core solid; flavor subacid; quality medium or below; seeds even with the surface.

Discussion. Though grown commercially in Western Oregon as an early berry some years ago (**36 [1909-10]**), it has been replaced by better sorts. Not to be recommended.

Fairfield.

Historical. A chance seedling originating with M. Johnson, of N. J., previous to 1900 (**48**). Has been regarded as of some promise in N. Y. (**48**), Ohio (**4**), and eastern Canada (**32**).

Description. *Plant* medium to below in both size and vigor; spreading; healthy; crowns below medium in number, of medium size; a fair plant maker; low in yield. *Flower* perfect; flowering season medium to early. *Fruit stems* medium to short; fruit not held up well. *Fruit* below medium; conic; dark red; flesh light red; medium firm; core solid; flavor subacid; quality medium to below; seeds even with the surface.

Discussion. Of no promise.

Fendall.

Historical. A seedling of Belt, originating with Fendall & Son, Towson, Md., and introduced in 1907 (**49**). Regarded as semi-promising in N. Y. (**49**), Ind. (**38**), and Va. (**54**).

Description. *Plant* small; weak; rather spreading; not healthy; crowns few and small; a poor plant maker; above medium in yield the first season, but later has been very unsatisfactory. *Flower* imperfect; flowering season medium. *Fruit stems* medium long; not holding fruit up well. *Fruit* medium; conic to long conic; medium to light red; flesh medium to light red; core solid; flavor subacid; quality medium; seeds somewhat depressed.

Discussion.—Of no promise.

Florella.

Synonym. Florello (**4**).

Historical. A cross between Bubach and Lady Thompson, originating with J. P. H. Brown, Augusta, Ga. (**48**). The general criticism against it has been that it is a light yielder (**48, 4, 46**).

Description. *Plant* above medium in both size and vigor; quite erect; healthy; crowns medium or above in both size and number; a fair plant maker; below medium in yield. *Flower* semi-perfect; flowering season medium. *Fruit stems* medium long; fruit held up medium well. *Fruit* medium to above; round conic, sometimes compressed; medium red; flesh medium to light red; medium to rather soft; core solid or half hollow; flavor mildly sweet; quality medium to above; seeds even with the surface.

Discussion. Of no promise.

Fremont Williams.

Historical. A cross between Gandy and Bush Cluster, originating with Louis Hubach, of Ark. (1911 Catalog M. Crawford Co.) In Ohio (**3, 4**) and Va. (**54**) it has produced large berries but has not been very prolific.

Description. *Plant* medium in size and vigor; semi-spreading; fairly healthy; only a fair plant maker; crowns few, medium or above in size; low in yield. *Flower* perfect. *Fruit* below medium; conic; light red; flesh light red; medium firm; core solid; flavor acid; quality medium or below; seeds even with the surface.

Discussion. Of no promise.

Gandy.

Synonym. Gandy's Prize. (**1** [**1891**]).

Historical. A cross between Jersey Queen and Glendale, originating in New Jersey (**53**). It has been one of the most prominent commercial varieties in the eastern states where it has been valued especially as a late market variety. Corbett, for instance, recommends (**10**) it for 8 of the 18 pomological districts east of the Rocky Mountains.

Description. *Plant* small; rather weak; low and spreading; healthy; a fair plant maker; crowns below medium in both size and number; low in yield. *Flower* perfect; flowering season medium to late. *Fruit* medium in size; rather irregular conic; medium red; flesh light red; medium firm; core solid or hollow; flavor subacid, slightly astringent; quality below medium; seeds slightly raised.

Discussion. Of no promise.

Gill.

Historical. Originated about 1898 with E. H. Ekey, Steubenville, Ohio; supposed to be the result of crossing a seedling of Bubach with Bederwood (**48**). Ohio (**4**) and Ind. (**38**) report very favorably upon it as an early variety; N. Y. (**48**) finds it less satisfactory.

Description. *Plant* medium or a little above in both size and vigor; rather spreading; fairly healthy; crowns few, large; a rather poor plant maker; medium in yield. *Flower* perfect; flowering season medium to early. *Fruit* below medium; conic; bright red; flesh light red; medium firm; core solid; flavor mild subacid; quality medium; seeds even with the surface.

Discussion. Of no promise.

Gladstone.

Historical. Originated about 1893 with F. F. Merceron, Catawissa, Pa.; supposed to be a seedling of Sharpless (**48**). Not regarded very favorably by either the N. Y. (**48**) or Mich. (**44**) Experiment Stations on account of lack of firmness.

Description. *Plant* medium or a little above in both size and vigor; rather spreading; healthy; a fair plant maker; crowns medium in both number and size; above medium in yield. *Flower* perfect; flowering season medium. *Fruit stems* medium long, fruit held up medium well. *Fruit* medium in size, quite uniform; conic, usually compressed; medium to dark red; flesh medium to light red; medium firm; core solid or slightly hollow; flavor mild subacid; quality medium; seeds slightly raised.

Discussion. Of little promise.

Glendale.

Historical. A chance seedling found near Akron, O., in 1871. (1880 Catalog M. Crawford Co.) At one time recommended for the Willamette Valley (**9**); but has evidently never been grown here to any extent.

Glen Mary.

Historical. Of Pennsylvania origin (**47**). Has been quite generally successful in the eastern states. Among those where it has notably succeeded as a market sort may be mentioned: Mass. (**1** [**1909**]), N. Y. (**47**), Ohio (**22**), Mich. (**44**), Col. (**31**). It also succeeds in eastern Canada (**32**).

Description. *Plant* a little above medium in both yield and vigor; a little spreading; fairly healthy; crowns below medium in number, large; a good plant maker; above medium in yield. *Flower* semi-perfect; flowering season medium. *Fruit stems* medium long; fruit held up quite well. *Fruit* below to above medium in size; broad conic, rather irregular; dark red; flesh medium red; medium to rather soft; core solid; flavor mildly sweet to subacid, rather insipid; quality medium to below; seeds even with the surface.

Discussion. Though it has been mentioned (**36** [**1907-8**]) as bearing profitable crops in some of the coast counties of Oregon, it is probably inferior to several other varieties and is not to be recommended in this state.

Gold Dollar.

Historical. Originated with Mr. Z. Mills, of Springbrook, Ore.; supposed to be a seedling of Excelsior (**36** [**1909-10**]).

Description. *Plant* above medium to large; vigorous; quite erect; healthy; crowns medium in size, medium or above in number; a good plant maker; below medium in yield. *Flower* perfect; flowering season early to medium. *Fruit stems* medium long; fruit held up medium well. *Fruit* medium in size, fairly uniform; round conic; dark red; flesh medium red; medium firm to a little soft; core solid; flavor sweet subacid; quality medium; seeds even with the surface.

Discussion. Though not as productive as desirable, this is probably the most satisfactory early variety that is grown in the State. It averages from a week to ten days earlier than our other standard varieties. For this reason it brings good prices. It is not to be recommended, however, for purposes other than early near-by markets. It does not possess sufficient firmness to make it a good fruit to ship long distances or to can.

Golden Gate.

Historical. Originated in 1903 with S. H. Warren, Weston, Mass.; supposed to be a seedling of Marshall (**48**). In at least four eastern states—Mass. (**1** [**1909**]), N. Y. (**48**), Va. (**54**), and Ohio (**25**)—it has been reported promising.

Description. *Plant* slightly below medium in both size and vigor; semi-spreading; healthy; crowns few, above medium in size; a medium plant maker; above medium in yield the first season under trial, but has since been less satisfactory. *Flower* perfect; flowering season medium. *Fruit stems* medium to short; fruit not held up well. *Fruit* medium to above, fairly uniform; broad conic to round conic; dark red; flesh medium red; medium to rather soft; core solid; flavor mildly sweet to insipid; quality medium to below; seeds even with the surface.

Discussion. Of no promise.

Goodell.

Historical. Originated near Seattle, Wash.; introduced by the Sunnyside Nursery Co., of Sunnyside, Wash.

Description. *Plant* medium in both size and vigor; erect-spreading; healthy; crowns few, medium to large; a fair plant maker; below medium in yield. *Flower* perfect; flowering season medium. *Fruit stems* medium long; fruit held up well. *Fruit* medium to below, fairly uniform; roundish to broad conic; dark red; flesh dark red; soft; core solid; flavor sweet, slightly musky, slightly insipid; quality medium to below; seeds slightly raised.

Discussion. Of no promise.

Good Luck.

Historical. Originated with E. Pedrick of N. J. (1910 Catalog of M. Crawford Co.). Has been reported as of promise in three eastern states—N. Y. (**48**), Mich. (**46**), and Ohio (**25**).

Description. *Plant* medium or a little above in size and vigor; rather erect; crowns medium or a little above in both size and number; healthy; a medium plant maker; medium in yield. *Flower* perfect; flowering season medium. *Fruit stems* medium to short; fruit held up fairly well. *Fruit* medium in size, fairly uniform; broad conic, somewhat compressed; medium red; flesh medium red; medium firm; core solid; flavor subacid to acid; quality medium; seeds even with the surface.

Discussion. Of no promise.

Granville.

Historical. Originated with A. M. Nichol, of Ohio; supposed to be a seedling of Miner (1903 Catalog of M. Crawford Co.) Reported upon favorably from Ohio (**22**) and unfavorably from Mich. (**45**).

Description. *Plant* below medium in both size and vigor; semi-erect; fairly healthy; a poor to fair plant maker; crowns below medium in both size and number; above medium in yield the first season that it was under trial, but has since been unsatisfactory. *Flower* perfect. *Fruit* medium to below; round conic; light red; flesh light red; rather soft; flavor acid; quality medium; seeds slightly depressed.

Discussion. Of no promise.

Great Scott.

Historical. A cross between Bubach and Belmont, originating with

John Scott, Newton, Mass. (48). The Ohio Exp. Sta. (4) has reported upon it half favorably, the N. Y. Exp. Sta. (48) less favorably.

Description. *Plant* below medium in size and vigor; erect; healthy; crowns few, above medium in size; a rather poor plant maker; low in yield. *Flower* imperfect. *Fruit* medium to below; roundish; light red; flesh light red; rather soft; flavor almost neutral; quality below medium; seeds even with the surface or depressed.

Discussion. Of no promise.

Hampden.

Historical. At one time recommended for the Willamette Valley (9), but has evidently never succeeded here.

Hartnell.

Description. *Plant* medium to below in both size and vigor; erect-spreading; healthy; crowns few, large; a good plant maker; below medium in yield. *Flower* perfect; flowering season medium. *Fruit stems* short; fruit held up fairly well. *Fruit* medium to below, fairly uniform; roundish conic; dark red; flesh medium to light red; medium firm; core solid; flavor mild subacid; quality medium; seeds even with the surface or slightly raised.

Discussion. Of no promise.

Haverland.

Historical. Originated with B. H. Haverland, of Ohio; a cross between Crescent and Sharpless (1888 Catalog of M. Crawford Co.) Has been one of the dominant varieties in the eastern states for many years. Among those where it has been definitely recommended as a commercial variety are: Mass. (1 [1909]), N. Y. (40), Ohio (17), Mich. (45), Ill. (1 [1900]), Ind. (38).

Description. *Plant* medium in size and vigor; semi-spreading; healthy; crowns medium in number and size; a fair plant maker; medium in yield. *Flower* imperfect. *Fruit* medium in size, fairly uniform; conic; light red; flesh light red; rather soft; core solid; flavor subacid; quality medium; seeds even with the surface or somewhat raised.

Discussion. Though grown some in Western Oregon fifteen years ago (13 [1897-98]), it is not to be recommended now.

Henderson.

Historical. Tried at this Experiment Station a number of years ago and found unsatisfactory (9).

Highland.

Synonym. Highland Seedling (22).

Historical. Originated as a chance seedling near Lisbon, Ohio, about 1898 (49). Has been reported as very promising in N. Y. (49), Ohio (22, 4), Mass. (1 [1909]), and Va. (54); and as less promising in Ind. (38).

Description. *Plant* medium or a little above in size and vigor; rather spreading; healthy; crowns medium in size and number; above medium in yield the first season tested, but less satisfactory later. *Flower* imperfect; flowering season medium. *Fruit stems* rather short; fruit not held up very well. *Fruit* below medium; roundish; medium red; flesh medium to light red; soft; flavor mildly sweet; quality medium; seeds somewhat depressed.

Discussion. Of no promise.

Hopkins Choice.

Description. *Plant* above medium to large; vigorous; quite erect; healthy; crowns numerous, of medium size; a poor plant maker; medium to below in yield. *Flower* perfect; flowering season medium. *Fruit stems* medium long; fruit held up fairly well. *Fruit* medium to below, rather var-

able; broad conic, usually compressed; dark red; flesh medium red; medium firm; core solid; flavor rather neutral; quality medium to below; seeds even with the surface or slightly raised.

Discussion. Mr. E. L. Wolfer reports this variety as doing well with him in the Rogue River Valley, but it has not been more than a very mediocre sort in the Station trials. Not to be recommended.

Hovey.

Synonyms. Hovey's Seedling, Germantown, Young's Seedling (**15**).

Historical. Mentioned here simply because it was the first cultivated variety of strawberry to be introduced into this State. (**36** [**1891-2**]).

Howard.

Historical. Has been reported unsatisfactory in at least one eastern state—Ohio (**25**).

Description. *Plant* small; lacking in vigor; quite erect; fairly healthy; crowns few, medium to below medium in size; a poor plant maker; low in yield. *Flower* imperfect. *Fruit stems* short; fruit not held up well. *Fruit* below medium; round conic; dull red; flesh light red; rather soft; core solid; flavor somewhat astringent; quality poor; seeds somewhat raised.

Discussion. Of no promise.

Hummer.

Historical. Originated in Mich. (1908 Catalog of R. M. Kellogg Co.). Reports from N. Y (**48**), Ohio (**4**), Mich. (**48**), and Va. (**54**) Experiment Stations are that it is rather unsatisfactory.

Description. *Plant* medium in both size and vigor; semi-spreading; healthy; crowns below medium in number, medium to above in size; a fair plant maker; low in yield. *Flower* perfect; flowering season medium. *Fruit stems* medium long; fruit held up medium well. *Fruit* below to above medium in size, rather variable; broad conic, often compressed; dark red; flesh medium red; quite firm; core solid; flavor subacid, slightly astringent; quality medium or below; seeds partly raised.

Discussion. Of no promise.

Ideal.

Historical. One report from the Mich. Exp. Sta. (**45**), states that it is quite promising, though reports from the Experiment Stations of N. Y. (**41**), Ohio (**25**), and Wis. (**16**) are less favorable.

Description. *Plant* below medium in both size and vigor; rather spreading; fairly healthy; crowns few, large; a good plant maker; low in yield. *Flower* perfect; flowering season medium to late. *Fruit stems* medium long; fruit held up well. *Fruit* medium to a little below, uniform; conic; medium to dark red; flesh medium red; medium to rather soft; core solid; flavor sweet subacid; quality medium; seeds raised.

Discussion. Of no promise.

James Todd.

Historical. Originated with Henry Schnell of Mo. (1912 Catalog of Flansburgh & Son.)

Description. *Plant* medium in both size and vigor; spreading; healthy; crowns medium in size, below medium in number. A good plant maker; low in yield. *Flower* perfect; medium to late in flowering season. *Fruit stems* medium long; fruit held up fairly well. *Fruit* medium to a little below, fairly uniform; roundish to broad conic; medium to red; flesh medium to light red; medium to rather soft; core solid; flavor sweet subacid; quality medium; seeds depressed.

Discussion. Of no promise.

Jessie.

Historical. Originated in Wis. about 1880 with F. W. Loudon (**51** [**1886**]); a seedling of Sharpless (**32**). A variety that has proved very profitable in some sections of the East and unsatisfactory in many other sections. Among sections finding it profitable may be mentioned Va. (**54**), Mo. and Kan. (**35** [**1890**]).

Description. *Plant* above medium in size and vigor; quite erect; healthy; crowns medium in size, numerous; a good plant maker; medium in yield. *Flower* perfect; flowering season medium to early. *Fruit stems* medium long; fruit held up quite well. *Fruit* medium to below, uniform; round conic, regular; medium red; flesh medium red; medium firm; core solid; flavor subacid; quality medium; seeds even with the surface.

Discussion. Though formerly grown to some extent in Western Ore. (**36** [**1897-98**]), it has been displaced by better varieties. Not to be recommended.

Jim Dumas.

Historical. Originated with Louis Hubach, Judsonia, Ark. (**1** [**1907**]) said to contain the blood of Barton Eclipse, Gandy and Excelsior (1909 Catalog M. Crawford & Co.) Reports from the Ind. (**38**) and Ohio (**25**) Experiment Stations regarding it are none too favorable.

Description. *Plant* medium or a little above in size and vigor; fairly erect; quite healthy; crowns medium or above in both number and size; a poor plant maker; above medium in yield the first season, but below medium the two succeeding seasons. *Flower* perfect; flowering season medium to early. *Fruit stems* medium long; fruit held up medium well. *Fruit* below medium in size; round conic; dark red; flesh medium to dark red; quite firm; flavor subacid; quality medium; seeds depressed.

Discussion. Of no promise.

Johnson.

Synonyms. Johnson Early (**1** [**1909**]); Johnson's Early (**32**).

Historical. A cross between Crescent and Hoffman, originating in Md. (**32**). Reported as a promising early berry in eastern Canada (**32**) and Mich. (**44**); less satisfactory in Va. (**54.**)

Description. *Plant* below medium in both size and vigor; rather spreading; moderately healthy; crowns medium in number and size; a fair plant maker; yield low. *Flower* perfect; flowering season medium to early. *Fruit stems* medium long; fruit held up fairly well. *Fruit* below medium, uniform; conic; light red; flesh light red; medium firm; core solid; flavor subacid; quality medium or below; seeds somewhat depressed.

Discussion. Of no promise.

Jucunda.

Historical. Mentioned here because it was grown more or less commonly in this State twenty-five to thirty years ago. (**36** [**1891-92**]). Has been superseded by better sorts.

Kansas.

Historical. Originated in 1899 with J. J. Wittman, Emporia, Kan. (**48**). Reported as a promising variety in N. Y. (**48**); but as running too small in size for market purposes at the Ohio Exp. Sta. (**22**).

Description. *Plant* a little above medium in size and vigor; semi-erect; healthy; crowns medium or above in number, medium or below in size; a fair plant maker; medium to above in yield. *Flower* imperfect; flowering season medium to late. *Fruit stems* medium long; fruit held up fairly well. *Fruit* medium to small, rather variable; broad conic; dark red; flesh medium to

dark red, medium firm; core solid; flavor subacid, astringent; quality below medium; seeds even with the surface.

Discussion. Of no promise.

Klondike.

Synonyms. Klondyke (**54**); Louisiana (**1** [**1907**]).

Historical. Originated with R. L. Cloud, Independence, La. (**48**). This variety has apparently failed in many northern states—N. Y. (**48**), Ohio (**22**), Kan. (**1** [**1911**])—but is one of the leading varieties in the southeastern states where it is grown extensively for early shipments north (**1** [**1907**], **54**). Indiana reports favorably upon it (**38**).

Description. *Plant* medium or a little above in size and vigor; quite erect; healthy; crowns few, above medium in size; a good plant maker; medium in yield. *Flower* perfect; flowering season medium to early. *Fruit stems* medium long; fruit held up fairly well. *Fruit* medium to above; roundish; medium to dark red; flesh medium to dark red; firm to very firm; core solid; flavor acid, slightly astringent; quality below medium; seeds even with the surface.

Discussion. Of doubtful value here.

Louise.

Historical. Tried at this Experiment Station a number of years ago and found unsatisfactory. (**9**).

Lovett.

Synonym. Lovett's Early (1891 Catalog M. Crawford Co.).

Historical. A cross between Crescent and Wilson, originating with J. H. Norris, of Ky. (**53**). Formerly a leading commercial variety in portions of the Northeast (**20**). Recently it has been more or less generally superseded by other kinds.

Description. *Plant* medium or a little above in size and vigor; quite erect; moderately healthy; crowns above medium in number, of medium size; a fair plant maker; medium in yield. *Flower* pefect; flowering season medium. *Fruit stems* medium long, fruit held up fairly well. *Fruit* below medium in size; roundish conic; medium red; flesh light red; rather soft; core solid; flavor subacid; quality medium; seeds slightly raised.

Discussion. Though a few reports have come to the Experiment Station of heavy yields of this variety in Oregon, such yields are to be regarded as the exception. Furthermore, the variety does not possess the berry characters to make it valuable in this state. Not to be recommended.

Luther.

Synonym. August Luther (**1** [**1909**]).

Historical. Originated with August Luther, near Kansas City (**53**). It has proved to be a good variety for home use and local markets in a number of sections east of the Rock Mountains—notably eastern Canada (**32**), Ohio (**24**), Mich. (**46**), Kan. (**1** [**1911**]).

Description. *Plant* small; lacking in vigor; spreading; moderately healthy; crowns medium in number, small; a poor plant maker; low in yield. *Flower* perfect; flowering season medium to early. *Fruit* small; round conic; dark red; flesh light red; medium firm; core solid; flavor acid; somewhat astringent; quality below medium to poor; seeds slightly raised.

Discussion. Though this variety has been reported as having been grown successfully in Coos County (**36** [**1907–08**]), it is not to be recommended for this State.

Magoon.

Synonym. Magoon Seedling (**52**).

Historical. Originated as a chance seedling in the garden of W. J. Magoon, near Portland., Ore., and first introduced to the public in 1894 (**36** [**1909–10**]).

It is interesting to note that this variety, which is so vigorous and productive here, is weak and unproductive when grown in some of the eastern states (**55**), thus duplicating the behavior of many of the eastern varieties here.

Description. *Plant* large to very large; vigorous to very vigorous; quite erect; healthy; crowns numerous, large; a good plant maker; heavy in yield. *Flower* perfect; flowering season medium to early. *Fruit stems* medium to long; fruit held up well. *Fruit* medium to large, rather variable; broad conic, the larger sizes often a little irregular; dark red; flesh medium to dark red; medium to rather soft; core generally solid; flavor sweet subacid; quality medium to above; seeds even with the surface or depressed.

Discussion. Without question Magoon is the leading strawberry in Western Oregon. It is both the main season and late variety for home use and near-by markets. It is a favorite with the grower mainly because of its productiveness. He should remember, however, that it is not a variety that will ship long distances and arrive in the market in good condition. It is too soft for distant markets. It is likewise too soft for a commercial canning variety. To the extent that a local strawberry trade is profitable, Magoon is a profitable variety.

Magoon has often been planted with the idea that it is a "double cropper"; i. e., that it produces a fall as well as a spring crop of berries. Along with a number of other varieties Magoon shows some tendency to produce a light crop in the fall, especially when climatic and other environmental conditions are very favorable. Magoon, however, should not be planted primarily for this purpose, for there are other varieties that can be much more readily forced in the fall.

Malinda.

Historical. Supposed to have originated in the Pajaro Valley of California.

Description. *Plant* below medium in both size and vigor; erect-spreading; healthy; crowns medium in number, rather small; a fair plant maker; below medium in yield. *Flower* perfect; flowering season medium to late. *Fruit stems* medium long; fruit held up fairly well. *Fruit* below medium in size, uniform; conic to broad conic; dark red; flesh dark red; medium firm; core solid; flavor mild subacid; quality medium; seeds even with the surface.

Discussion. Of no promise.

Mammoth Beauty.

Historical. Has proved but fairly satisfactory in one of the eastern states—Ohio (**25**).

Description. *Plant* small; lacking in vigor; semi-spreading; fairly healthy; crowns few, of good size; a poor plant maker; low in yield. *Flower* perfect; flowering season medium to late. *Fruit stems* short; fruit not held up well. *Fruit* below medium to small, uniform; conic; medium to dark red; flesh medium red; medium firm; core solid; flavor mildly sweet, slightly astringent; quality medium to below; seeds slightly raised.

Discussion. Of no promise.

Marie.

Historical. A cross between Crescent and Cumberland, originating with Wm. Scarff of Ohio, in 1892 (**32**). Reported upon favorably from Ohio (**24**), eastern Canada (**32**), and Ind. (**38**).

Description. *Plant* small; weak; semi-spreading; moderately healthy; crowns few, of good size; a good plant maker; below medium in yield. *Flower* semi-perfect; flowering season medium to late; *Fruit stems* short; fruit not held up well. *Fruit* medium to large, rather variable; round conic, often compressed; medium to dark red, bright and glossy; flesh medium red; medium to rather soft; core solid; flavor mildly sweet, slightly musky; quality medium; seeds even with the surface.

Discussion. Of no promise.

Mark Hanna.

Historical. A seedling of Bubach, originating with M. T. Thompson, Rio Vista, Va. (**48**). Has done fairly well in the trial grounds of the N. Y. (**48**) and Ind. (**38**) Experiment Stations.

Description. *Plant* medium in both size and vigor; semi-spreading; healthy; crowns medium in size and number; a fair to poor plant maker; below medium in yield. *Flower* nearly pistillate; flowering season rather late. *Fruit stems* short; fruit not held up well. *Fruit* below medium, fairly uniform; conic, slightly necked; medium red; flesh medium to light red; medium firm; core solid; flavor subacid, slightly astringent; quality below medium; seeds slightly raised.

Discussion. Of no promise.

Marshall.

Historical. A chance seedling originating with M. F. Ewell of Mass. (**34** [**1892**]). A prominent variety that seems to be very exacting in its requirements. Many states where it has been tried; e. g., N. Y. (**48**), Mich. (**45**), Ohio (**20**), Mass. (**1** [**1909**]), Col. (**31**), report it as succeeding in certain locations and as being a failure in others.

Description. *Plant* above medium in size; vigorous; quite erect; healthy; crowns large, medium to below in number; a good plant maker; in the Station trials medium to below in yield. *Flower* perfect.; flowering season medium to early. *Fruit stems* medium to short; fruit held up fairly well. *Fruit* medium to large, rather variable; roundish conic; medium to dark red; flesh medium to light red; rather soft; core solid; flavor sweet subacid; quality medium to above; seeds slightly depressed.

Discussion. The behavior of this variety in this State is not greatly different from that in the states already mentioned. It has been unsatisfactory in the Station tests; at the same time it is known to be a commercial success in certain localities in Western Oregon. It is not a variety to be generally recommended. Only those sections where it is a proved success should attempt to grow it on a commercial scale. It is well worth trying in a limited way in those places where its behavior is not known and where there is need of a productive, mid-season, rather soft, local-market variety. It should be remembered, however, that even where it succeeds, it is not a variety to grow for long shipments or for the canning trade.

Mary.

Description. *Plant* is below medium in both size and vigor; rather spreading; fairly healthy; crowns few, medium in size; a fair plant maker; low in yield. *Flower* perfect; flowering season medium to late. *Fruit stems* short, but fruit held up quite well. *Fruit* medium, uniform; round conic; slightly necked; medium red; flesh medium red; medium to soft; core solid, flavor mild subacid; quality medium; seeds raised.

Discussion. Of no promise.

May King.

Historical. A seedling of Crescent (1887 Catalog M. Crawford Co.). A leading variety in N. Car. a number of years ago (**1** [**1891**]). Has been tried at Corvallis (**9**) with unsatisfactory results.

Mead.

Synonym. Meade (**1** [**1909**]).

Historical. Originated with O. E. Mead, Lunenburg, Mass., about 1896 (**48**). Has been reported as one of the leading varieties in Mass. (**1** [**1909**]) and as doing fairly well in N. Y. (**48**) and Va. (**54**).

Description. *Plant* medium in size and vigor; semi-spreading; moderately healthy; crowns below medium in number, above medium in size; a good

plant maker; below medium in yield. *Flower* perfect; flowering season medium to late. *Fruit stems* medium to short; fruit not held up well. *Fruit* medium in size, quite uniform; broad conic; dark red; flesh medium red; medium firm; core solid; flavor slightly sweet, slightly astringent; quality medium; seeds slightly raised.

Discussion. Of no promise.

Mellie.

Description. *Plant* small; weak; rather spreading; fairly healthy; crowns few, small; very poor plant maker; low in yield. *Fruit* medium to below in size; conic; medium red; medium firm; core solid; flavor subacid; seeds even with the surface or depressed.

Discussion. Of no promise.

Michel.

Synonyms. Michel's Early (**6**); Osceola (**18**); Ella (**18**).

Historical. A chance seedling found in Ark.; supposed to be a seedling of Crescent (1890 Catalog M. Crawford Co.). Has been widely recommended and grown as an early market variety in many sections of the East and Middle West (**10**).

Description. *Plant* above medium in both size and vigor; spreading; moderately healthy; crowns medium or above in both number and size; a good plant maker; low in yield. *Flower* perfect; flowering season medium to early. *Fruit stems* short; fruit not held up well. *Fruit* medium to below medium, uniform; round conic, regular, slightly necked; a light bright red; flesh light red; medium firm; core solid; flavor sweet subacid; quality medium; seeds even with the surface.

Discussion. Of no promise.

Michigan.

Synonym. Pride of Michigan (**1** [**1909**]).

Description. *Plant* above medium in both size and vigor; semi-erect; healthy; crowns below medium in number, above medium in size; a good plant maker; low in yield. *Flower* perfect; flowering season medium to early. *Fruit stems* medium to short; fruit held up fairly well. *Fruit* medium to large, rather variable; conic, sometimes compressed; dark red; flesh light red; medium to rather soft; core solid; flavor mildly sweet; quality above medium; seeds slightly raised.

Discussion. Of no promise.

Midnight.

Synonym. Hale's 11:59 P. M. (**53**).

Historical. A cross between Haverland and Parker Earle (**53**). Reported as unpromising by the N. Y. Exp. Sta. (**47**).

Description. *Plant* above medium in both size and vigor; semi-spreading; healthy; crowns medium in size, medium to above in number; a fair plant maker; above medium in yield. *Flower* perfect; flowering season medium. *Fruit stems* medium long; fruit held up well. *Fruit* medium to above, fairly uniform; conic; medium red; flesh rather light red; medium to soft; core solid; flavor subacid to sweet; quality medium; seeds slightly raised.

Discussion. Of no promise.

Miller.

Synonym. Dewey (1901 Catalog of M. Crawford Co.).

Historical. Originated with J. D. Miller of Ohio (**32**). Reported as promising in Ohio (**24**); and as unproductive at both Ottawa, Canada (**32**) and in Ind. (**38**).

Description. *Plant* above medium in both size and vigor; semi-spreading;

moderately healthy; crowns medium in size, below medium in number; a good plant maker; medium to above in yield. *Flower* perfect; flowering season medium to late. *Fruit stems* short; fruit held up quite well. *Fruit* medium to above, fairly uniform; round conic, often compressed; medium red; flesh light red; core solid; medium to rather soft; flavor mild subacid, slightly astringent; quality medium to below; seeds even with the surface.

Discussion. Of no promise.

Missionary.

Historical. Reported as one of the most popular varieties in Va. (**54**).

Description. *Plant* below medium in both size and vigor; spreading; healthy; crowns below medium in number, above medium in size; a good plant maker; low in yield. *Flower* perfect; flowering season medium to early. *Fruit stems* medium long; fruit not held up well. *Fruit* medium to below, fairly uniform; conic, somewhat compressed; medium to dark red; flesh medium to light red; medium firm; core solid; flavor subacid; slightly astringent; quality below medium; seeds even with the surface.

Discussion. Of no promise.

Monmouth.

Historical. Tried at this Experiment Station a number of years ago and found unsatisfactory (**9**).

Multnomah.

Historical. A cross between Clark and Gold Dollar, originating with L. S. Otis, Newberg, Ore.

Description. *Plant* variable, small to above medium in size; rather weak to above medium in vigor; erect-spreading; fairly healthy; crowns above medium in number, medium to below in size; a good plant maker; low in yield. *Flower* perfect; flowering season medium. *Fruit stems* medium to short; fruit held up fairly well. *Fruit* medium to below, fairly uniform; roundish conic; medium to dark red; flesh medium red; medium to firm; core solid; flavor mildly sweet; quality medium; seeds slightly raised.

Discussion. Not promising.

New Acme.

Historical. Originated with Mrs. Mabel Kaiser, Salem, Ore., about 1907. A seedling of Clark.

Description. *Plant* medium in size and vigor; semi-erect; moderately healthy; crowns medium in size, medium to above in number; a good plant maker; low in yield. *Flower* perfect; flowering season late. *Fruit stems* rather short but stiff; fruit held up well. *Fruit* medium to below, uniform; roundish oblate, regular; dark red; flesh dark red; very firm; core solid; flavor quite acid, slightly astringent; quality medium to below; seeds raised.

Discussion. Plainly of the Clark type, but in the tests here inferior to that variety in both size and yield. Not to be recommended.

New York.

Historical. A cross between Bubach and Jessie (1910 Catalog of W. N. Scarff.). Reported as promising in Va. (**54**), but reports from Ohio (**22**) and Ind. (**38**) are less favorable.

Description. *Plant* medium or a little above in both size and vigor; semi-spreading; healthy; crowns medium in number, medium to above in size; a good plant maker; below medium in yield. *Flower* perfect; flowering season medium to early. *Fruit stems* rather long; fruit not held up well. *Fruit* medium to above, quite uniform; conic to round conic, regular; medium red; flesh medium to light red; medium firm; core solid; flavor mildly sweet; quality above medium to good; seeds even with the surface.

Discussion. Of no promise.

Nick Ohmer.

Historical. Originated with J. F. Beaver of Ohio (**53**). Reports regarding it from Ont. (**53**), Ohio (**22**), Mich. (**44**), and Ind. (**38**) are quite favorable.

Description. *Plant* above medium in both size and vigor; rather erect; moderately healthy; crowns few, rather large; a medium plant maker; below medium to low in yield. *Flower* perfect; flowering season medium. *Fruit stem* medium long; fruit held up well. *Fruit* medium in size, fairly uniform; roundish conic; medium red; flesh medium to light red; medium to rather soft; core solid; flavor mildly sweet; quality medium; seeds even with the surface.

Discussion. Of no promise.

North Shore.

Historical. A seedling of Brandywine, originating in 1898 with W. H. Monroe, Beverly, Mass. (**48**). Reports regarding it from N. Y. (**48**), Ohio (**3**), and Va. (**54**) are unfavorable.

Description. *Plant* above medium in both size and vigor; quite erect; quite susceptible to leaf spot; crowns medium in number, large; a medium plant maker; low in yield. *Flower* perfect; flowering season medium to late. *Fruit stems* medium to short; fruit held up fairly well. *Fruit* medium in size, fairly uniform; conic; medium to dark red; flesh dark red; firm; core solid; flavor subacid; quality medium; seeds even with the surface.

Discussion. Of no promise.

Norwood.

Historical. Originated with N. B. White, Norwood, Mass.; supposed to be a cross of Marshall and Corsican (1910 Catalog of L. J. Farmer).

Description. *Plant* medium in size and vigor; spreading; fairly healthy; crowns medium in size and number; a poor plant maker; medium in yield. *Flower* perfect; flowering season medium to early. *Fruit stems* medium to short. *Fruit* medium in size; conic; dark red; flesh medium red; medium firm; core solid; flavor mildly sweet; quality medium.

Discussion. Of no promise.

Oaks Early.

Historical. Originated with Wm. Tull of Md. (**48**). Reports from the Experiment Stations of N. Y. (**48**), Va. (**54**), Ohio (**4**), and Ind. (**38**) are none too favorable.

Description. *Plant* small; weak; spreading; fairly healthy; crowns small, medium in number; a poor plant maker; below medium in yield. *Flowers* perfect. *Fruit* medium to below in size; conic; medium to dark red; flesh light red; medium firm; core solid; flavor subacid; quality medium to below.

Discussion. Of no promise.

Ohio.

Historical. Originated in Butler Co., Ohio (1887 Catalog M. Crawford Co.) Tried at this Experiment Station a number of years ago and found fairly satisfactory (**9**). Evidently it has never been grown in this State to any extent.

Ontario.

Historical. Tried at this Experiment Station a number of years ago and not found satisfactory (**9**).

Oom Paul.

Historical. A cross of Jessie and Bubach, introduced in 1903 (**32**). Reports from the Ohio (**22**) and Ind. (**38**) Experiment Stations are rather favorable.

Description. *Plant* small; weak; semi-erect; fairly healthy; crowns below medium in both number and size; a fair plant maker; low in yield. *Fruit* below medium to small, uniform; roundish conic; medium to light red; flesh

medium to light red; medium firm; core solid; flavor subacid; quality medium to below.

Discussion. Of no promise.

Oregon.

Synonyms. Admiral Dewey; Oregon Improved; Oregon Everbearing (incorrectly); New Oregon; Oregon Ironclad (incorrectly).

Historical. Originated near Salem, Ore., with Mr. A. F. Hofstadtler, who first called it Admiral Dewey, later changing its name to Oregon. It has been generally sold under this name. Recently what is apparently the same variety has been sold under the name New Oregon. It has also passed under the names Oregon Improved, Oregon Everbearing, and Oregon Ironclad, though the first of these synonyms has never gained any prominence. It should not be confused with either Oregon Everbearing or Oregon Ironclad, for both are distinct varieties. The true Oregon is the result of a cross between Marshall and Jessie.

Description. *Plant* above medium in both size and vigor; quite erect; moderately healthy; crowns medium in size, above medium in number; a good plant maker; medium to below medium in yield. *Flower* perfect; flowering season medium to early. *Fruit stems* medium long; fruit held up well. *Fruit* medium to above, occasionally large, rather variable; round to broad conic, often compressed; dark red; flesh medium red; medium to rather soft; core generally solid; flavor mild subacid; quality medium to above; seeds even with the surface.

Discussion. This variety is grown to a considerable extent in Western Oregon. It is especially suitable for home use, its fruiting season being a long one, though it is not an "everbearing" variety. It is also profitable in many sections for the local market. It is too soft a berry, however, to ship long distances or use for the canning trade. Its culture is not likely to be greatly extended, for it is generally outyielded by Magoon, which meets the same local market demand.

Oregon Everbearing.

Synonyms. Oregon (incorrectly); Oregon Ironclad (incorrectly); Everbearing (**36** [1889–90]).

Historical. Supposed to be a seedling of Triomphe de Gand; originated near Mt. Tabor, Portland, Ore., previous to 1890 (**36** [1891–92]). It is interesting to note that in the eastern and middle states and in eastern Canada this variety largely loses its "everbearing" habit and generally has given unsatisfactory results (**32, 5, 38**). Of interest also is the fact that in France, where climatic conditions are more like those of the western part of this State than like those of eastern America, it retains its "everbearing" habit and is said to be a profitable variety (**32**).

Description. *Plant* medium to a little below in both size and vigor; semi-spreading; quite healthy; crowns medium or above in number, medium to below in size; a fair plant maker; below medium in yield. *Flower* perfect; flowering season long, from early to very late. *Fruit stems* medium long; fruit not held up very well. *Fruit* medium to below in size, rather variable; conic, often compressed; light red; flesh light red to whitish; medium to rather soft; core solid; flavor sweet subacid; quality medium to above; seeds somewhat raised.

Discussion. This is a true "everbearing" variety, ripening some berries early in the season and continuing to ripen fruit until late fall. It is probably the best of the "fall-fruiting" varieties for Oregon conditions. Though many others show a tendency to bear some berries in the fall, this variety shows a much stronger tendency in that direction. It should be remembered, however, that to obtain a satisfactory crop of strawberries in the fall something more is necessary than just to plant a certain variety. Special cultural practices must be employed. The fall-fruiting tendency of this variety is something that will appeal more to the amateur than to the commercial grower. It may be mentioned in passing that Oregon Everbearing may always be readily distinguished

from Oregon and Oregon Ironclad by the direction of the pubescence on the petioles of the leaves. In this variety it is *appressed and ascending;* in the other two it is *spreading.*

Oregon Ironclad.

Synonyms. Oregon (incorrectly); Oregon Everbearing (incorrectly).
Historical. Recently reported upon rather unfavorably in Ind. (**38**).
Description. *Plant* medium or a little above in size and vigor; semi-spreading; quite healthy; crowns few, large; a fair plant maker; yield below medium to low. *Flower* perfect; flowering season medium; *Fruit* medium in size; roundish; medium red; flesh light red; medium to rather soft; core solid; flavor mildly sweet; quality medium; seeds slightly raised.
Discussion. Not recommended.

Oswego.

Historical. Supposed to be a cross between Bubach and Sharpless (**48**). The Experiment Stations of N. Y. (**48**) and Ohio (**25**) report unfavorably upon it; those of Va. (**54**) and Ind. (**38**) give half-favorable reports.
Description. *Plant* medium or below in size and vigor; semi-spreading; healthy; crowns medium in size, quite numerous; a fair plant maker; below medium in yield. *Flower* perfect; flowering season medium to early. *Fruit stems* rather short; fruit held up fairly well. *Fruit* medium in size, rather variable; conic; medium to light red; flesh medium to light red; medium to soft; core solid; flavor subacid, slightly astringent; quality below medium; seeds even with the surface or slightly raised.
Discussion. Of no promise.

Paris.

Description. *Plant* medium to above in size and vigor; erect; healthy; crowns few, medium to above in size; a fair plant maker; low in yield. *Flower* perfect; flowering season medium. *Fruit* medium in size; round conic; medium to dark red; flesh medium red; rather soft; core solid; flavor subacid; quality medium; seeds even with the surface or somewhat depressed.
Discussion. Of no promise.

Palmer Early.

Description. *Plant* medium in size and vigor; semi-erect; moderately healthy; crowns below medium in number, above medium in size; a fair plant maker; above medium in yield. *Flower* perfect; flowering season medium; *Fruit stems* medium long; fruit held up fairly well. *Fruit* medium in size, uniform; conic to broad conic, often compressed; dark red; flesh medium red; medium firm; core solid; flavor rather acid; quality medium to below; seeds even with the surface.
Discussion. Of no promise.

Parker Earle.

Historical. Originated with J. Minon of Texas in 1886; a seedling of Crescent fertilized with T. V. Munson's No. 3, which was a seedling of Miner (1890 Catalog of M. Crawford Co.). It has met with general favor in many of the eastern states as a variety for nearby markets. (**1** [**1890**], **10**).
Description. *Plant* medium to a little above in size and vigor; erect; healthy; crowns medium in size, above medium in number; a fair plant maker; above medium in yield the first season under trial, but has since been less satisfactory. *Flower* perfect; flowering season medium. *Fruit stems* rather short; fruit held up fairly well. *Fruit* medium in size, fairly uniform; conic; medium red; flesh light red; medium firm or a little soft; core solid; flavor subacid, slightly astringent, rather insipid; quality below medium; seeds even with the surface.

Discussion. This variety is reported productive in the Rogue River Valley by Mr. E. L. Wolfer and it was productive a portion of the time in the Station tests. The qualities of its fruit, however, are not such as to warrant recommending it.

Parson.

Synonym. Parson's Beauty (**1** [**1909**]).

Historical. Originated in Md. about 1891 (**32**). Has been quite generally successful in the northeastern states (**22, 1** [**1909**], **38**) and in eastern Canada (**32**), where it is grown for both fresh consumption and canning.

Description. *Plant* medium in both size and vigor; rather erect; healthy; crowns below medium in number, above medium in size; a fair to poor plant maker; medium to below in yield. *Flowers* perfect; flowering season medium. *Fruit stems* rather short; fruit not held up very well. *Fruit* medium to below in size, fairly uniform; broad conic; medium to dark red; flesh medium to light red; medium firm; core solid; flavor subacid, slightly astringent; quality medium to below; seeds slightly raised.

Discussion. Of no promise.

Paul Jones.

Historical. A cross between Haverland and Brandywine, originating with W. H. Johnson, Northboro, Mass., about 1898 (**49**). Reported as productive at the N. Y. Exp. Sta. (**49**), but inferior in quality.

Description. *Plant* below medium in both size and yield; rather spreading; healthy; crowns below medium in number, above medium in size; a fair plant maker; above medium in yield the first season under trial, unsatisfactory afterwards. *Flower* imperfect; flowering season medium to late. *Fruit stems* medium long; fruit not held up well. *Fruit* medium to above in size; conic, somewhat irregular; medium to light red; flesh light red; medium firm; core solid; mildly sweet to mildly subacid; quality medium to below; seeds somewhat depressed.

Discussion. Of no promise.

Peabody.

Historical. A variety under this name has been mentioned (**36** [**1891-2**]) as desirable for Oregon, though Coote (**9**) reported unfavorably upon it in 1891. It is uncertain whether or not the variety here referred to is distinct from the Old Scarlet of Downing (**12**). It has evidently passed out of cultivation in this State.

Pearl.

Historical. Originated in N. J. in 1884 (**30**). Has formerly been unfavorably reported upon by this Station (**9**).

Pineapple.

Historical. Probably several distinct eastern varieties have gone under this name. It is not known which one was formerly tried at this Station and reported upon unfavorably (**9**).

Pineapple Flavored.

Historical. A chance seedling originating about 1896 with a Mr. Talmage, Mt. Morris, N. Y. (**48**).

Description. *Plant* below medium in both size and vigor; quite erect; healthy; crowns few, of medium size; a rather poor plant maker; low in yield. *Flower* perfect. *Fruit* small; round conic; bright red; flesh medium to light red; quite firm; core solid; flavor mildly sweet; quality medium; seeds somewhat depressed.

Discussion. Of no promise.

Pioneer.

Historical. A variety of Oregon origin that at one time was well spoken of (**1** [1897]), but that has evidently gone out of cultivation.

Poco Moke.

Historical. There have been favorable reports on this variety from Ind. (**38**), Ohio (**22**), and Ottawa, Canada (**32**).

Description. *Plant* medium in size and vigor; rather spreading; healthy; crowns below medium in number, above medium in size; a fair plant maker; medium in yield. *Flower* perfect; flowering season medium to late. *Fruit stems* medium to short; fruit held up medium well. *Fruit* medium to above in size, fairly uniform; broad conic, compressed or irregular; medium red; flesh medium to light red; medium to soft; core slightly hollow; flavor slightly sweet, slightly musky; quality medium to below; seeds partly raised.

Discussion. Of no promise.

President Roosevelt.

Historical. A cross between Warfield and Clyde, originating with A. Y. Cathcort, Bristol, Ind. (**48**). Unfavorably reported upon from N. Y. (**48**).

Description. *Plant* medium to below in both size and vigor; semi-spreading; moderately healthy; crowns medium in number and size; a fair plant maker; low in yield. *Flower* imperfect. *Fruit* small; roundish, slightly necked; medium to light red; flesh light red; medium to soft; core solid; flavor mildly sweet to neutral; quality below medium.

Discussion. Of no promise.

Quality.

Historical. A cross between Hunn and Atlantic, originating on the grounds of the N. Y. Agr. Exp. Sta. in 1899 (**48**).

Description. *Plant* medium in both size and vigor; semi-spreading; moderately healthy; crowns medium to above in number, medium to below in size; a rather poor plant maker; medium in yield the first season under trial, but since then has been very unsatisfactory. *Flower* perfect. *Fruit* medium in size; conic; dark red; firm; core solid; flavor somewhat sweet; quality medium to above; seeds depressed.

Discussion. Of no promise.

Red Bird.

Historical. A cross between Murray and Hoffman, originating in 1902 with S. Wherry, Furant, Miss. Reports on this variety from the Experiment Stations of Va. (**54**), N. Y. (**49**), Ohio (**25**), and Ind. (**38**) are to the effect that it is rather unpromising.

Description. *Plant* small; weak; semi-erect; fairly healthy; crowns very few in number, below medium to medium in size; a very poor plant maker; low in yield; *Flower* imperfect. *Fruit* below medium in size; roundish; bright red; flesh light red; rather soft; core solid; flavor acid; quality below medium; seeds slightly raised.

Discussion. Of no promise.

Reliance.

Historical. Reported as a total failure in Ohio (**4**).

Description. *Plant* small; weak; erect; fairly healthy; crowns very few, rather large; a very poor plant maker; low in yield. *Flower* perfect. *Fruit* medium to below in size; roundish; dark red; flesh medium red; medium firm; core solid; flavor subacid; quality medium; seeds depressed.

Discussion. Of no promise.

R. H. Smith.

Description. *Plant* a little below medium in both size and vigor; semi-spreading; healthy; crowns above medium in number, below medium to small in size; a good plant maker; below medium in yield. *Flower* perfect; flowering season medium to early. *Fruit stems* short; fruit held up fairly well. *Fruit* medium to below in size, rather variable; roundish conic, slightly necked; bright red; flesh light red; medium to rather soft; core solid; flavor mildly sweet; quality medium; seeds even with the surface.

Discussion. Of no promise.

Richmond.

Description. *Plant* medium in both size and vigor; semi-spreading; healthy; crowns medium in size, medium or below in number: a medium plant maker; low in yield. *Flower* imperfect; flowering season medium to early. *Fruit stems* medium to short. *Fruit* medium to below in size; conic; light red; flesh light red; medium to firm; core solid; flavor acid; quality medium to below; seeds somewhat depressed.

Discussion. Of no promise.

Ridgway.

Historical. A cross between Jersey Queen and Parker Earle, originating with a Mr. Ridgway of Ind. (**53**). In some sections of the east; e. g., Ont. (**53**), and Mich. (**44**)—this variety has been regarded as a good commercial sort. It has also been reported (**31**) as a leading variety in some parts of Col. However, it has never become a dominant variety.

Description. *Plant* a little below medium in both size and vigor; semi-erect; fairly healthy; crowns below medium in number, above medium in size; a fair plant maker; low in yield. *Flower* perfect; flowering season medium. *Fruit stems* rather short. *Fruit* medium to small; roundish conic; medium red; flesh light red; medium to soft; core solid; flavor subacid; quality medium.

Discussion. Of no promise.

Rockhill Seedlings—Nos. 1–12.

Historical. Mr. Harlow Rockhill, a strawberry breeder of Conrad, Ia., within the last few years has sent out plants of a number of his new varieties. Those sent out under the numbers 1–12 (inclusive) have been on trial at this Station. Certain of these seedlings have since been given permanent names and placed on the general market. Nearly all contain blood of the Pan-American, a true fall-bearing variety; and all have been bred especially for fall-fruiting purposes. The results with all of these seedlings on the Experiment Station grounds have been unsatisfactory. They have all fruited freely in the fall, the fruiting season extending over a long period. Their total yields, however, have been below medium to light. The plants themselves have grown to medium size but have lacked vigor and vitality. Without exception they have been very poor plant makers. It may be that in soils much lighter than that of the Station grounds these varieties would give much better results; but they cannot be recommended on the basis of their record here. There are many minor points of difference between the different varieties in question, but as the general statement just made holds for all of them, it is not considered necessary to make detailed descriptions of each one.

Rough Rider.

Historical. Supposed to be a cross between Bubach and Gandy, originating in 1893 (**48**). Reported upon favorably by the N. Y. Exp. Sta. (**48**) and rather unfavorably by the Ohio (**24**) and Ind. (**38**) Experiment Stations.

Description. *Plant* below medium in both size and vigor; quite erect; moderately healthy; crowns medium or above in number, below medium in size; a poor plant maker; below medium in yield. *Flower* perfect. *Fruit*

medium in size; roundish conic; medium red; flesh light red; medium firm; core solid; flavor rather acid; quality below medium; seeds even with the surface.

Discussion. Of no promise.

Ruby.

Historical. Originated with E. H. Riehl, North Alton, Ill., in 1890; supposed to be a cross between Crescent and Sharpless (**48**). It has given good results in trials in Ont. (**53**), Ohio (**20**), and Mich. (**44**); less satisfactory results in N. Y. (**48**).

Description. *Plant* small; weak; semi-erect; healthy; crowns few, medium in size; a medium plant maker; low in yield. *Flower* perfect; flowering season rather late. *Fruit stems* short; fruit not held up well. Fruit medium in size, fairly uniform; round conic; medium red; flesh light red; rather soft; core solid; flavor mildly sweet; quality medium; seeds even with the surface or slightly raised.

Discussion. Of no promise.

Sample.

Historical. Discovered as a chance seedling in Mass. by J. D. Gowing in 1894 (**32**). This variety has become a leader in many sections of the East and Middle West; e. g., Mass. (**1** [**1911**]), N. Y. (**41**), Ohio (**22**), Mich. (**44**), Ont. (**53**), Ind. (**38**), Kan. (**1** [**1911**]).

Description. *Plant* medium in both size and vigor; semi-erect; healthy; crowns large, below medium in number; a medium plant maker; low in yield. *Flower* imperfect; flowering season medium. *Fruit stems* rather short; fruit held up fairly well. *Fruit* medium to below in size, uniform; conic; medium red; flesh light red; medium firm; core solid; flavor mild subacid; quality medium; seeds slightly raised.

Discussion. Of no promise.

Saratoga.

Historical. A cross between Glen Mary and Sample, originating with Wm. Palmer, Rexford Flats, N. Y., in 1903 (**48**). Reported favorably by the N. Y. Exp. Sta. (**48**), but less favorably by the Experiment Stations of Va. (**54**) and Ind. (**38**).

Description. *Plant* medium in size and vigor; rather spreading; healthy; crowns medium in number, above medium in size; a good plant maker; above medium in yield. *Flower* perfect; flowering season rather early. *Fruit stems* medium long; fruit held up fairly well. *Fruit* medium to above in size, rather variable; broad conic; dark red; flesh medium to light red; medium firm; core solid; flavor mildly sweet to subacid, slightly astringent; quality medium; seeds slightly raised.

Discussion. Of little promise.

Seaford.

Synonym. Lloyd's Favorite (**32**).

Historical. Originated near Seaford, Del. (**32**). It has been found a satisfactory variety in Ont. (**53**), and in the Del., N. J., Va. section (**10, 54**).

Description. *Plant* below medium to small; weak; rather spreading; healthy; crowns few, medium in size; a rather poor plant maker; below medium in yield. *Flower* imperfect; flowering season medium. *Fruit stems* short. *Fruit* below medium in size; conic; dark red; flesh medium red; rather soft; core solid; flavor mildly sweet, slightly astringent; quality medium to below; seeds even with the surface.

Discussion. Of no promise.

Senator.

Description. *Plant* small; weak; spreading; healthy; crowns below medium in number, medium to above in size; a rather poor plant maker; above medium in yield the first season tried, but since then very unsatisfactory. *Flower* perfect; flowering season medium to early. *Fruit stems* short; fruit held up well. *Fruit* medium to below, uniform; round conic; dark red; flesh medium to light red; medium to rather soft; core solid; flavor slightly sweet, slightly astringent; quality medium; seeds even with the surface or slightly raised.

Discussion. Of no promise.

Sharpless.

Historical. A seedling of Col. Cheney, Jucunda, Chas. Downing or Wilson (**43**) originating with a Mr. Sharpless of Pa. (**1** [**1879**]). It has been one of the dominant varieties in American strawberry culture, as is evidenced by its being at one time recommended for nine of the 18 pomological districts of the U. S. and Canada (**10**). A number of years ago it was grown to some extent in Western Oregon (**36** [**1897–98**]). It has also been more or less prominent in Cal. (**52**) and B. C. (**1** [**1911**]).

Description. *Plant* above medium in both size and vigor; nearly erect; crowns below medium in number, large; healthy; a medium plant maker; below medium in yield. *Flower* perfect; flowering season medium. *Fruit stems* medium long; fruit not held up well. *Fruit* above to below medium, fairly uniform; conic, compressed; medium to dark red; flesh medium red; medium firm; core solid, inclined to be fibrous; flavor almost neutral; quality medium; seeds even with the surface.

Discussion. Has been superseded by better varieties.

Sixteen to One.

Historical. A letter from E. L. Wolfer, Central Point, Ore., dated Jan. 15, 1912, states that in the nineties Mr. Geo. Irwin of Ashland, Ore., received a number of unnamed seedling strawberry plants from M. Crawford Co., of Ohio. One of these seedlings was later named Sixteen to One by Mr. Irwin.

Description. *Plant* large; vigorous; quite erect; crowns large, numerous; moderately healthy; a good plant maker; above medium to heavy in yield. *Flower* perfect; flowering season medium to early. *Fruit stems* rather long; fruit held up well. *Fruit* medium to large, rather variable; broad conic, more or less irregular when large; medium to salmon red; flesh medium to light red; rather soft; core solid or slightly hollow; flavor mildly sweet, slightly musky; quality above medium; seeds slightly depressed.

Discussion. Though the plant characters of this variety are such as to recommend it, it is handicapped by its undesirable fruit characters. It has never gained more than very local prominence and cannot be considered promising.

Splendid.

Historical. Originated with C. H. Sumner of Ill. (**53**). It has been reported favorably from Ont. (**53**), Wis. (**16**), and parts of Col. (**31**); and less favorably from Mich. (**45**).

Description. *Plant* small; weak; rather spreading; moderately healthy; a fair plant maker; crowns below medium in both number and size; low in yield. *Flower* perfect; flowering season medium. *Fruit* medium in size; broad conic; medium red; rather soft; core solid; flavor subacid to neutral; quality below medium; seeds slightly raised.

Discussion. Of no promise.

Stevens.

Synonyms. Stevens Late (**38**); Stevens Late Champion (**1** [**1909**]).

Historical. Said to be a cross between Bayvue and Pride of Cumberland; originated in 1897 with Arthur Stevens, Bridgeton, N. J. (**48**). Favorable reports regarding it have been made by the Experiment Stations of N. Y. (**48**) and Ohio (**4**). It has also been reported as promising in Kan. (**1** [**1911**]), Mass. (**1** [**1909**]), and Ind. (**38**).

Description. *Plant* above medium in both size and vigor; healthy; rather spreading; crowns above medium in both size and number; a fair to good plant maker; above medium in yield. *Flower* perfect; flowering season medium to late. *Fruit stems* rather short; fruit not held up well. *Fruit* medium to above, fairly uniform; broad conic, fairly regular; medium to dark red, frequently with green tips; flesh medium red; medium firm; core solid; flavor subacid; quality medium; seeds even with the surface or slightly depressed.

Discussion. Of little promise.

Success.

Historical. Has been reported promising in Va. (**54**), Ohio (**24**), and at Ottawa, Can. (**32**).

Description. *Plant* above medium in both size and vigor; quite erect; healthy; crowns medium in number, above medium in size; a fair plant maker; heavy in yield the first season under trial but unsatisfactory after that. *Flower* perfect. *Fruit stems* medium long. *Fruit* medium to above in size; round conic; bright red; medium firm; core soild; flavor mildly subacid; quality medium; seeds even with the surface or slightly depressed.

Discussion. Of no promise.

Summit.

Historical. Tried at this Experiment Station a number of years ago and not found satisfactory (**9**).

Sunshine.

Historical. Of Delaware origin (1901 Catalog of M. Crawford Co.). Reported as unpromising by the Ohio Experiment Station (**22**).

Description. *Plant* medium in size and vigor; semi-erect; healthy; crowns medium to numerous, medium in size; a good plant maker; heavy to very heavy in yield. *Flower* perfect; flowering season medium. *Fruit stems* medium to short; fruit held up fairly well. *Fruit* below to above medium in size, fairly uniform; broad conic, somewhat compressed; medium to dark red; flesh medium to dark red; rather soft; core solid; flavor mildly sweet to subacid; quality medium; seeds somewhat depressed.

Discussion. More promising than most of the varieties tried, but the berries are too soft to make the culture of the variety worth while here.

St. Louis.

Historical. A cross between Haverland and Thompson originating in 1904 with J. A. Bauer, Judsonia, Ark. (**48**). It has been reported productive at both Va. (**54**) and N. Y. (**48**) Experiment Stations, but too soft for other than local markets.

Description. *Plant* medium in size and vigor; healthy; rather spreading; crowns medium in number and size; a medium plant maker; medium to below in yield. *Flower* perfect; flowering season early. *Fruit stems* rather short; fruit not held up well. *Fruit* below medium to small; round conic; medium red; flesh medium to light red; rather soft; core solid; flavor sweet to subacid; quality medium; seeds somewhat depressed.

Discussion. Of no promise.

Tennessee.

Synonym. Tennessee Prolific (**53**).

Historical. A cross between Crescent and Sharpless, originating with a Mr. Hodges in Tenn. (**53**). Has apparently done especially well in Ont. (**32, 53**) and the Del., N. Y., Va. district (**10, 54**).

Description. *Plant* above medium in both size and vigor; rather spreading; healthy; crowns below medium in number; above medium in size; a fair plant maker; medium to below in yield. *Flower* perfect; flowering season medium. *Fruit stems* medium long; fruit not held up very well. *Fruit* medium to below in size, fairly uniform; round conic; dark red; flesh medium red; medium firm; core solid; flavor mildly sweet to subacid; quality medium; seeds even with the surface or slightly raised.

Discussion. Of no promise.

Texas.

Historical. Has been reported as promising by the Experiment Stations of Va. (**54**), Ohio (**22**), and Ind. (**38**).

Description. *Plant* above medium in both size and vigor; erect; healthy; crowns medium in number, above medium in size; a good plant maker; below medium in yield. *Flower* perfect; flowering season early. *Fruit stems* medium long; fruit not held up well. *Fruit* medium to below in size, fairly uniform; broad conic; medium red; flesh medium to light red; medium firm; core solid; flavor somewhat acid; quality medium; seeds even with the surface.

Discussion. Of no promise.

Third Class.

Description. *Plant* medium in both size and vigor; semi-erect; healthy; crowns below medium in number, above medium in size; a fair plant maker; medium in yield. *Flower* imperfect; flowering season rather late. *Fruit stems* medium long; fruit held up fairly well, *Fruit* below to above medium in size, fairly uniform; broad conic; medium to dark red; flesh medium to light red; rather soft; core solid or half-hollow; flavor mildly sweet to mildly subacid, almost insipid; quality below medium; seeds even with the surface.

Discussion. Of no promise.

Thompson.

Synonym. Lady Thompson (**1** [**1909**]).

Historical. A seedling of Michel (Catalog of Stump & Walter Co.). It has been reported as giving unsatisfactory results in N. Y. (**39**), Ohio (**20**), Ind. (**38**), and Wis. (**16**); reported as doing quite well in Va. (**54**); has been recommended for the southeastern states (**10**).

Description. *Plant* below medium in both size and vigor; semi-erect; quite healthy; crowns medium in size, below medium in number; a fair plant maker; below medium in yield. *Flower* perfect; flowering season medium to early. *Fruit* small; round conic; light red; flesh light red; medium firm; core solid; flavor rather acid; quality below medium; seeds even with the surface.

Discussion. Of no promise.

Thompson No. 2.

Description. *Plant* above medium in both size and vigor; semi-spreading; healthy; crowns medium in number, large; a medium plant maker; below medium in yield. *Flower* perfect; flowering season medium to late. *Fruit stems* medium long; fruit not held up well. *Fruit* medium to large, fairly uniform; roundish conic; usually compressed; dark red; flesh medium to light red; rather soft; core hollow or solid; flavor mild subacid; quality medium; seeds slightly raised.

Discussion. Of no promise.

Three W.'s.

Historical. Originated with W. W. Wallace, of Tenn., in 1901 (**49**). Half-favorable reports on this variety have been made by the Experiment Stations of N. Y. (**48**) and Va. (**54**).

Description. *Plant* small; weak; moderately healthy; semi-erect; crowns medium in number, rather small; a poor plant maker; above medium in yield the first season under trial, but has been very unsatisfactory ever since. *Flower* perfect. *Fruit* medium to below in size; round conic; dark red; flesh medium red; medium to soft; core solid; flavor subacid; quality medium; seeds slightly raised.

Discussion. Of no promise.

Triomphe de Gand.

Historical. A Belgian variety introduced into this country by Patrick Barry (**1** [**1862**]). At one time one of the three leading varieties in the U. S. (**51** [**1869**]). Mentioned here because it was one of the leading varieties in this State before the introduction of the Clark (**36** [**1909-10**]). Probably not grown here now.

Van Deman.

Historical. A cross between Crescent and Captain Jack, originating in Ark. (**53**). Though favorably reported upon by this Station a number of years ago (**9**), it has never been grown here to any extent.

Vick.

Synonym. James Vick (**1** [**1909**]).

Historical. A Missouri variety, said to be descended from Wilson (**35** [**1883**]). Mentioned here because it has been reported (**36** [**1903-04**]) as a commercial variety in parts of Western Oregon. It has evidently gained no more than a very local prominence.

Vick's Uncle Joe.

Historical. Reported as unproductive at South Haven, Mich. (**46**).

Description. *Plant* below medium in both size and vigor; rather spreading; fairly healthy; crowns few, medium in size; a fair plant maker; below medium in yield. *Fruit* below medium in size; round conic; light red; flesh light red; medium firm; core solid; flavor mild subacid; quality medium; seeds even with the surface or slightly depressed.

Discussion. Of no promise.

Virginia.

Historical. Originated in Va., said to be a cross between Hoffman and Sharpless (**48**). Reports regarding this variety from the Experiment Stations of N. Y. (**48**), Ohio (**4**), and Ind. (**38**), are partly favorable; a report from the Mich. Experiment Station (**46**) is much less favorable.

Description. *Plant* small; weak; spreading; moderately healthy; a fair plant maker; crowns few, small; low in yield. *Flower* imperfect. *Fruit* small; round; medium red; flesh light red; rather soft; core solid; flavor subacid; quality below medium; seeds slightly depressed.

Discussion. Of no promise.

Warfield.

Historical. Originated with B. C. Warfield, of Southern Ill.; supposed to be a cross between Crescent and Wilson (**53**). It has been one of the important varieties in the American strawberry industry. The following references, which indicate recommendations for the section named, give some

idea of its usefulness and wide range of adaptation: eastern Canada (**32**), Ohio (**17**), Mich. (**45**), Ill. (**1** [**1909**]), Mo. (**35** [**1887**]), Col. (**31**).

Description. *Plant* above medium to large; vigorous; moderately healthy; erect; a fair plant maker; crowns numerous, medium in size; medium in yield. *Flower* perfect; flowering season medium to late. *Fruit stems* medium long; fruit held up quite well. *Fruit* medium to below in size; fairly uniform; conic; dark red; flesh dark red; medium firm; core solid; flavor subacid; quality medium to below; seeds half raised.

Discussion. Of no promise.

Wilson.

Synonym. Wilson's Albany, Albany Seedling (**50**).

Historical. Without doubt Wilson has been the most important single variety in the history of the American strawberry industry. Originating over 50 years ago near Albany, N. Y., it immediately gained front rank among the varieties of that day, and it still remains an important commercial variety in some parts of the country. Examination of the reports of the American Pomological Society and of the various State Horticultural Societies will show that at one time or another it has been the leading variety in nearly every state in the Union. There have been many unfavorable criticisms made, but in spite of them all, it continued to hold its own. For practically 25 years it held almost undisputed sway. During the last 30 years, however, it has gradually been yielding its prominence to first one variety and then another. It has often been suggested that Wilson is essentially a pioneer variety, a variety that does its best only upon virgin soils, or at least on soils that have not been long under cultivation. There is certainly considerable evidence to support this view. Anyway, it is now grown extensively in only a few of the newer sections of the country.

Description. *Plant* above medium in both size and vigor; erect-spreading; fairly healthy; crowns medium or above in both number and size; a medium plant maker; medium in yield. *Flower* perfect; flowering season medium to early. *Fruit stems* medium long; fruit held up well. *Fruit* medium to above, somewhat variable; broad conic; dark red; flesh dark red; firm; core solid; flavor acid; quality below medium; seeds even with the surface, sometimes depressed.

Discussion. This variety is still considerably grown in Western Oregon. There is frequent complaint, however, that it is unproductive. It is grown mainly for the canning trade and to ship considerable distances. There is no great demand for it in local markets because of its inferior quality. It can be recommended for strong soils where there is profit in growing a firm red berry for the canneries.

Wolverton.

Synonym. Woolverton (**11**).

Historical. Originated with John Little, Granton, Ont. (**53**). Its plant characters have been reported unfavorably by the Can. Dept. of Agr. (**11**) and by the Va. Exp. Sta. (**53**).

Description. *Plant* small; weak; rather spreading; moderately healthy; crowns below medium in both size and number; a fair plant maker; low in yield. *Flower* perfect. *Fruit* small; conic; medium to light red; flesh light red; medium firm; core solid; flavor mildly sweet; quality below medium; seeds slightly raised.

Discussion. Of no promise.

World's Wonder.

Historical. Originated with S. G. Parsons of Md. (**48**).

Description. *Plant* medium in size and vigor; spreading; healthy; crowns medium in both number and size; a fair plant maker; medium to below in yield. *Flower* perfect; flowering season medium to late. *Fruit stems* rather short;

fruit not held up well. *Fruit* medium in size, quite uniform; conic to broad conic, compressed; medium red; flesh medium to light red; medium to soft; core solid; flavor mildly sweet to subacid; quality medium; seeds slightly depressed.

Discussion. Of no promise.

A Condensed Statement Regarding the Varieties Reported Upon.

One hundred and ninety-six varieties are reported in this publication as having been tried on the Station grounds or as having been grown in the State. Probably many other varieties have at one time or another been brought here and grown for a short time under our conditions, only to disappear without leaving any impression upon our strawberry industry. The 196 varieties, however, have stayed long enough so that there is some printed record regarding their performance here. Of these 196, eight may be said really to have succeeded. Two of these eight, Jucunda and Triomphe de Gand, were among the earliest varieties to be introduced, and though grown considerably at one time, have practically disappeared from cultivation. They were grown at a time when strawberry growing was not a specialized industry, at least on the Pacific Coast, and when the requirements of a strawberry variety were not so exacting as they are now. The other six varieties—Wilson, Clark, Magoon, Marshall, Oregon, and Gold Dollar—are with us still and go to make up the commercial plantings of today. This is not a very large percentage to "make good" out of the number that have been tried. Even the area over which some of these six are grown is contracting. Wilson is gradually disappearing. It cannot remain much longer. Only its superior canning qualities keep it in cultivation. Thus the tendency is for the commercial list to become smaller, rather than larger—and this in the face of the many new introductions each year.

Where Have Our Commercial Varieties Originated?

It may be well to inquire here where the commercial varieties of this section originated. Triomphe de Gand and Jucunda, which were grown some time ago, were of European origin. Wilson originated in New York. It is the one of the six grown today that is losing ground most rapidly. Marshall, which probably ranks fifth in the State, is of Massachusetts origin. The other four—Clark, Magoon, Oregon, and Gold Dollar—all originated in this State. These are the four that for the past five years have led all others and that today are further in the lead than they have been at any preceding time.

What is the interpretation, if any, to be placed upon these facts? Is it that eastern varieties will not adapt themselves to our soil and climatic conditions—that they will not thrive here? The Station's variety test seems to answer this question in the negative. Many of the varieties prominent in the East; e. g., Bederwood, Buster, Crescent, Dunlap, Dornan, Excelsior, Glen Mary, Haverland, Lovett, Saratoga, Warfield, have given good results from the viewpoints of both plant growth and yield. They probably grow and produce as well here, in fact, as in those sections of the East where they are grown commercially. Yet they are not grown here and are not to be recommended to Oregon growers.

Again the question, "Why?" The answer is that we are gradually learning that we must grow a different type of strawberry than they can and do grow in most of the eastern states—a type that is adapted to a method of marketing that they are not forced to employ. In other words, our market requirements are of necessity different from the market requirements of the eastern strawberry grower. As has been already stated, a large strawberry industry can be built up here only on the basis of a very firm, excellent-shipping, excellent-canning variety, that may be sold fresh and in perfect condition between the Rocky Mountains and Chicago, or that may be sold in cans anywhere. Eastern states do not absolutely need, and consequently do not have, such a variety.

This does not mean that we shall never obtain an eastern variety that will be of great value to us. Through the operation of the law of chance, it is not only possible but probable that we shall. On the other hand, varieties of western origin, bred for our conditions and with our peculiarly exacting market requirements in mind, are much more apt to prove of value than those of eastern origin. That the one variety found in this test most worthy of trial (Ettersburg No. 121), outside of the regular commercial list, is of western origin, is evidence in support of this assertion. The Oregon grower who plants more than a very small area to a new eastern variety has less than a gambler's chance of finding anything worth while.

Specific Recommendations.

Gold Dollar may be recommended as the most satisfactory early variety for the Oregon grower. It is soft in texture, however, and cannot be shipped considerable distances.

Magoon is the leading main season variety for local markets. It is not a canning variety and cannot be shipped considerable distances.

Marshall takes the place of Magoon in a few localities.

Clark is the leading variety for shipping any considerable distance. It is also the leading variety for canning purposes.

Wilson is a good canning variety for some of the stronger soils.

Oregon is a good variety for strictly local markets. It has a long fruiting season and is of good quality, and is consequently valuable for the home garden.

References Cited.

1. American Pomological Society Report. (Dates cited are within brackets [ ].
2. Bailey. Encyclopedia of American Horticulture. Fourth Edition. 1906.
3. Ballou. The Strawberry Test Plot. Bul. No. 178, Ohio Agr'l Exp. Sta. 1906.
4. Ballou. Strawberries; the Newer Varieties. Bul. No. 186, Ohio Agr'l Exp. Sta. 1907.
5. Beach. Strawberries. Bul. No. 64, N. Y. Agr'l Exp. Sta. 1894.
6. Beach. Notes on Strawberries. Bul. No. 76, N. Y. Agr'l Exp. Sta. 1894.
7. Beach. Notes on Strawberries. Bul. No. 91, N. Y. Agr'l Exp. Sta. 1895.
8. Cardwell. Brief History of Early Horticulture in Oregon, 1906. Portland.
9. Coote. Comparative Test for Strawberries. Bul. No. 12, Ore. Agr'l Exp. Sta. 1891.
10. Corbett. Strawberries. Farmers' Bul. No. 189, U. S. Dept. Agr. 1904.
11. Craig. Strawberries. Bul. No. 27, Can. Dept. Agr. 1897.
12. Downing. Fruits and Fruit Trees in America. Fourteenth Edition. 1856.
13. Fletcher. Varieties of Fruits Originating in Michigan. Sp. Bul. No. 44, Mich. Agr'l Exp. Sta. 1910.
14. Fuller. The Strawberry Culturist. 1887.
15. Fuller. The Small Fruit Culturist. 1889.
16. Goff. Variety Tests of Small Fruits. Bul. No. 72, Wis. Agr'l Exp. Sta. 1898.
17. Green. Notes on Small Fruits. Vol. II, No. 4. Ohio Agr'l Exp. Sta. 1889.
18. Green. Notes on Small Fruits. Vol. III, No. 7, Ohio Agr'l Exp. Sta. 1890.
19. Green. Notes on Small Fruits. Vol. IV, No. 6, Ohio Agr'l Exp. Sta. 1891.
20. Green. Strawberries. Bul. No. 85, Ohio Agr'l Exp. Sta. 1897.
21. Green. Strawberries. Bul. No. 98, Ohio Agr'l Exp. Sta. 1899.
22. Green and Ballou. Varieties of Strawberries. Bul. No. 154, Ohio Agr'l Exp. Sta. 1904.
23. Green and Ballou. The Newer Strawberries. Bul. No. 166, Ohio Agr'l Exp. Sta. 1905.
24. Green and Waid. Varieties of Strawberries. Bul. No. 146, Ohio Agr'l Exp. Sta. 1903.
25. Green et al. Strawberries; the Newer Varieties. Bul. No. 236, Ohio Agr'l Exp. Sta. 1912
26. Gurney. Northwestern Pomology. 1894.
27. Hooper. Western Fruit Book. 1857.
28. Hunn. Experiments with Strawberries. Bul. No. 24, N. Y. Agr'l Exp. Sta. 1890.
29. Hunn. Experiments with Strawberries. Bul. No. 36, N. Y. Agr'l Exp. Sta. 1891.
30. Lyon. Fruit Testing at the South Haven Sub-station. Bul. No. 55, Mich. Agr'l Exp. Sta. 1889
31. Longyear. Strawberry Growing in Colorado. Bul. No. 140, Col. Agr'l Exp. Sta. 1909.
32. McCoun. Strawberries. Bul. 62, Can. Dept. Agr. 1909.
33. Manning. Book of Fruits. 1838.
34. Mass. Hort. Soc. Trans. (Dates cited are within brackets [ ].)
35. Mo. Hort. Soc. Repts. (Dates cited are within brackets [ ].)
36. Ore. Bd. Hort. Repts. (Dates cited are within brackets [ ].)
37. Ore. Hort. Soc. Proc., 25th Ann. Meet. 1910.
38. Oskamp. Strawberries. Bul. No. 164, Purdue Uni. Agr'l Exp. Sta. 1913.
39. Paddock. Strawberries. Bul. No. 109, N. Y. Agr'l Exp. Sta. 1896.
40. Paddock. Strawberries. Bul. 127, N. Y. Agr'l Exp. Sta. 1897.
41. Paddock. Variety Tests of Strawberries. Bul. No. 147, N. Y. Agr'l Exp. Sta. 1898.
42. Powell. The Orchard and Fruit Garden. 1905.
43. Roe. Success with Small Fruits. 1886.
44. Taft and Dean. Notes on Strawberries. Bul. No. 189, Mich. Agr'l Exp. Sta. 1901.

45. Taft and Gladden. Strawberries. Bul. No. 148, Mich. Agr'l Exp. Sta. 1897.
46. Taft and Wilken. Rept. of South Haven Experiment Station for 1908. Sp. Bul. No. 48, Mich. Agr'l Exp. Sta. 1909.
47. Taylor. Varieties of Strawberries and Cultural Directions. Bul. No. 276, N. Y. Agr'l Exp. Sta. 1906.
48. Taylor. Varieties of Strawberries and Cultural Directions. Bul. No. 309, N. Y. Agr'l Exp. Sta. 1908.
49. Taylor. Newer Varieties of Strawberries with Cultural Directions. Bul. No. 336, N. Y. Agr'l Exp. Sta. 1911.
50. Thomas. American Fruit Culturist. 1867.
51. Reports or Yearbooks of the U. S. Dept. of Agr. (Dates cited are within brackets [ ].)
52. Wickson. California Fruits. Fifth Edition. 1910.
53. Woolverton. Fruits of Ontario. 1906.
54. Cole. Bul. No. 6, Va. Truck Exp. Sta. 1912.
55. Taft and Gladden. Strawberry Notes for 1899. Bul. No. 176, Mich. Agr'l Exp. Sta. 1899.

PART II.

Report

OF THE

Department of Entomology

Introduction.

This report, the second prepared under the Crop Pest and Horticultural Law of 1911, contains a general statement of the investigations carried on by the members of the department during the years 1913 and 1914. The first report published under this law contained a somewhat general survey of the more serious insect pests of the State known to us at that time.

All of the matter contained in the present report has been taken from records of original investigation, and contains notes on a number of species not mentioned in the first report. A number of investigations which were under way at the time when the first report was issued have been concluded, and the others are still in progress. Immediate demands have required us to take up new problems in addition to those reported here, which will be reported at a later date.

The problems and investigations now under way are as follows:

1. The Garden Slugs (Nearly complete).
2. The Loganberry Root Borer (*Bembecia marginata*).
3. The Rose-Leaf Hopper as a Fruit Pest (*Empoa rosae*).
4. The Strawberry Root Weevils.
5. The Cucumber Beetles.
6. Insecticide Investigations.
7. Clover and Alfalfa Insects.
8. The Woolly Apple Aphis.

We have continued our policy of visiting those sections where serious outbreaks of injurious insects have occurred; and all life-history studies have been carried on under field conditions where the problems would permit. Considerable time has been spent in experiments with insecticides, and field tests have been made with all of the promising sprays of recent origin. As a result of this work we are now in a position to answer inquiries relating to the efficiency of the sprays investigated.

One feature of our present organization is the establishment of temporary field stations at Hood River and in the Milton Freewater district. As soon as satisfactory methods for handling the insect troubles of these districts have been secured, the men at these stations will be shifted to other sections of the State to work on the insect problems found there. If this plan is not interrupted, it is hoped that in the course of a few years all sections of the State will receive the personal services of a member of the staff.

In the preparation of this report, due credit should be given Assistant Professor Lovett, Mr. Leroy Childs, Mr. G. F. Moznette, and Mr. L. G. Gentner for assistance in making insectary records and for gathering data and making photographs. Miss Mary Irwin has been extremely helpful in looking after office matters, preparing manuscripts, etc.

Special acknowledgments are due Dr. L. O. Howard, Chief of the U. S. Bureau of Entomology; Dr. A. L. Melander, of Washington State College; Dr. A. D. McGillivray, of the University of Illinois; Dr. E. C. Van Dyke and Prof. E. P. Van Duzee, of the University of California; and Messrs. H. S. Smith and H. L. Vierick, of the California State Insectary, for determinations and other assistance.

H. F. WILSON.

THE FRUIT TREE LEAF SYNETA.

Syneta albida Leconte.

By H. F. WILSON AND G. F. MOZNETTE

Order, Cleoptera. Family, Chrysomelidae.

The origin and distribution of this insect cannot be determined at this time, for the reason that it has never been recorded outside of the Pacific Northwest. The senior writer has collected it as far north as Seattle, Washington, and as far south as Eugene, Oregon. It has not been recorded as appearing east of the Cascade Range. In Oregon it is commonly found throughout the Willamette Valley and up the Columbia River as far as The Dalles. In all probability, it also exists throughout the Oregon coast region, as we have an authentic record of its being found in and around Myrtle Point, Coos County, Oregon.

Nature and Extent of Injury.

The injury caused by this insect is twofold in its entirety, since the larvae feed on the fibrous roots and the adults feed on the flowers, foliage, and fruits of all of our fruit trees. Just how much injury is caused by the larvae feeding on the roots is hard to estimate; the trees do not show a definite retardation of growth and it is a question whether the number of larvae found could destroy enough of the fibrous root system to cause serious damage. That they do feed on the fibrous root system can hardly be doubted, as they spend a considerable part of the larval stage below the layer of earth in which the roots of grasses and weeds are found. In several cases we have found them in cells against the larger roots, but without finding any indication of feeding punctures.

The injury caused by the adults is more severe on young trees and on young grafts. During the past season, however, considerable injury has been done to the fruit itself in the case of apple, pear, cherry, and prune. In all cases the

Fig. 11. Cherries deformed as a result of Syneta injury.

injury caused by the adults is seen in the spring shortly after their emergence. If petals of any of our fruit trees are out, these soon become riddled by the attacks of the insects, as shown in Plate I, Fig. 5. About the same time the adults may also be found eating holes in the foliage. On larger trees the injury to the foliage is not so readily apparent as the injury to the petals. Occasionally, however, the leaves are so badly injured as to cause alarm. (Plate I). At a later period, as the petals disappear, the attack on the leaves increases and as the young fruit develops, one can find the stem and fruit badly nibbled. As a result of this later injury, the fruit either drops or beocmes scarred so badly as to be unsalable as first, or even second-grade fruit. While the feeding punctures in the petals are quite conspicuous, we do not believe that the resulting injury is so important, since no harm is done to the fruit-forming parts of the flower.

In the case of new grafts of prunes and apples, the adults sometimes occur in such numbers as to destroy the entire leaf surface; this in many cases means the death of the graft so injured.

Life-History.

Hibernation. The winter is spent in the larval stage. At the time when winter starts in, a great many larvae are mature or nearly so; while others are not more than half grown. Hibernation takes place in earthen cells at from six inches to 14 or more inches below the surface of the ground.

Pupae. The first pupae (Fig. 1, c) begin to form about the first of March and the adults begin appearing along about the middle of March, depending

Fig. 1. The Fruit Tree Leaf Syneta (*Syneta albida*). a, The larva; b, the egg; c, the pupa; d, adult female; e, adult male. (Original.)

Plate I.

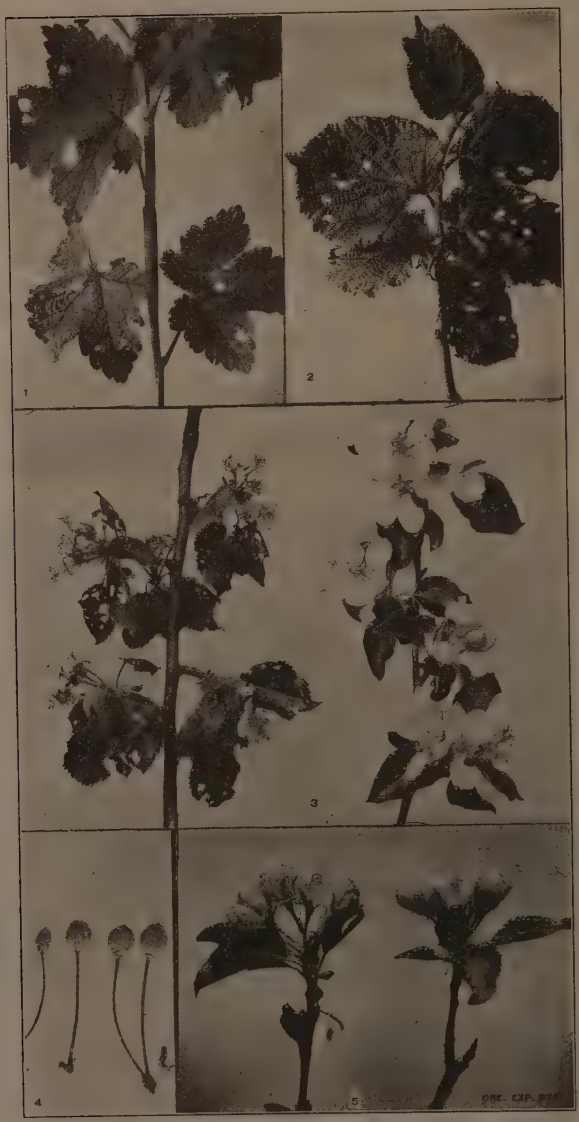


Plate I. The Fruit Tree Leaf Syneta (*Syneta albida*). 1. Injury to currant leaves. 2. Injury to filbert leaves. 3. Injury to apple (left); uninjured petals and leaves from same tree (right). 4. Injury to young apples. 5. Injured and uninjured flower cluster (Original.)

upon the early spring temperatures. The pupae can be found from February 25 to May 10 and reach a maximum abundance at the end of March or beginning of April. Minimum length of pupal stage is 11 days; average 15 and 16 days; and maximum observed 22 days.

When first formed the pupa is pure white in color and remains so for about seven to nine days, when the eyes turn red and the tips of the caudal filaments turn dark. When the legs and antennae are about to separate from the body, they become light brown and the mandibles become dark brown on the outer half. Head furnished with two sets of long hair-like spines, each set consisting of three, placed just opposite the eyes. Prothorax with 15 to 20 short to long hairs mostly in a band across the center. The mesothorax, the metathorax, and each segment of the abdomen bear a row of about 10 spines along the dorsum. Tip of each knee joint also with two hairs. Length of pupa five to six mm.

The Pupal cell, made entirely of earth, is simply an oblong oval cell not much larger than the pupa.

The Adults begin to appear about the first of March and remain in evidence until about the middle of June. The suddenness with which they may be said to appear is probably due to the fact that immediately after emergence they find their way to the opening flower and leaf buds and remain there more or less hidden until disturbed. This is especially true if the weather is chilly or rainy. On sunny days they move about quite freely and can be seen flying about the orchard and feeding on the petals and leaves. When a tree upon which they are resting is jarred or disturbed, they quickly drop to the ground and, when present in numbers, appear like falling petals.

The depth at which the pupae are found in the ground might lead one to believe that the adults would have a hard time escaping, but in reality they are able to work out quite rapidly, due perhaps to the fact that they are found mostly in cultivated ground. Many observations were made in open ground, and under trees of various kinds in the orchard, where extensive observations were made in sod and cultivated areas, and as a rule very few specimens were found where the orchard was kept in sod.

No specimens were taken in open ground nor were they found among young trees. That they may be found promiscuously distributed, however, can easily be seen from the fact that the eggs are deposited indiscriminately over the ground, with very little attempt to hide them. The males and females, which are readily distinguishable, appear at the same time, and copulation takes place shortly after emergence. Under normal conditions egg laying begins at once, but may be delayed by weather conditions and the adults may live up to a maximum of six weeks or longer.

Fig. 2. The Fruit Tree Leaf Syneta (*Syneta albida*). Drawings to show detail structure. a, larva: b, egg (natural size and enlarged); c, pupa; d, adult female; e, adult male. (Original.)

Description of Adults. (Fig 1, d). When first emerged from the pupal cases, the adults are almost uniformly pure white. The wing covers are exceedingly soft and tender. Almost immediately they begin to harden and in a short time the distinguishing characters of the males are apparent.

The original description [1], by Dr. J. T. Leconte is included:

"*S. albida.* Palilda elongata, capite thoraceque grosse punctatis, hoc lateribus medio acute tuberculatis, utrinque constricto, antrorsum subangustato; elytris confertim serriatim punctatis, costa dorsali obsoleta alterque a humero ad apicem extensa. Long. 28."

"Oregon: Mr. Townsend and Dr. Suckley."

The Male. General color of antennae, head, thorax, and legs, brown; wing covers dirty white with a dusky or black streak down the inner edge of each. Mandibles black at the tip and yellowish at the base. Eyes nearly oval and shining black in color. Head, prothorax, and wing covers very strongly punctuated and covered with fine white or yellowish hairs. Length, six to seven mm.

The Female. General color of antennae, head, and thorax, a cream-colored brown. Wing covers creamy white. The females are without the black stripe which is found in the male. Head, prothorax, and wing covers strongly punctuated and hairy as in the male. Prothorax broadened on the sides into a dentate tubercle.

The Egg. When first deposited the eggs are pearly white and later turn yellowish. They are oval in shape and at times appear to be covered with a brown membrane of some kind as shown in Fig. 1, a. This covering is not generally found and probably is not normal. Length of egg .6 mm. We have been unable to get definite data on the egg-laying habits; but in breeding cages the eggs are deposited more or less promiscuously about over the ground, although under clods, etc. How the larvae penetrate to the depths mentioned has not been ascertained. There remains a possibility that the eggs are sometimes deposits on foliage, but repeated observations indicate otherwise. The length of the egg stage, moreover, has not been definitely determined on account of our inability to secure fertile eggs. Eggs collected from breeding cages failed to hatch in seven weeks' time. Mr. A. F. Barss, who did minor graduate work in this department, reports that the eggs hatch in from 15 to 21 days.

The larvae (Fig. 1, b) are grub-like in form and white in color. As soon as feeding begins the alimentary canal can be seen through the body wall. They may be found at practically all times of the year, as the late-hatching individuals do not reach maturity until a correspondingly late period the following spring. In August all sizes, from small to half-grown larvae, are very abundant. In October many seem to be about mature, while others are about half grown. Observations made during the summer and fall months indicate that the larvae soon after hatching find their way to the more solid and hard-packed soil. On October 1, 1914, the stages indicated were found at a depth of six to 10 inches below the surface of the soil among the fibrous roots of apple. The larval cell or burrow cannot be traced beyond the immediate cell of the larva, each individual cell being slightly larger than the larva and oval in shape, with the inside surface smooth.

Description of Larva. General color white, head light brown. Mandibles, margin of clypeus, and tips of legs dark brown. Ventral part of the body appears dark, due to food in the alimentary canal. Entire body furnished with spine-like hairs. Those on the dorsal part of the body are hair-like. Those on the underside are much shorter and are decidedly spine-like. (See Fig. 2). Those on the underside of the body are in rows mounted along the apex of the folds of each segment and appear to be used by the larvae in crawling. Normally the larvae rest in a curved position and do not seem to be able to straighten out the body.

Food Plants.

The original food plant or plants are not known, but at the present time our fruit trees seem certainly to be preferred to other trees. The adults feed

1. U. S. P. R. Exp. and Surveys, Zoology, 47th Parallel Report on Coleoptera collected by Leconte.

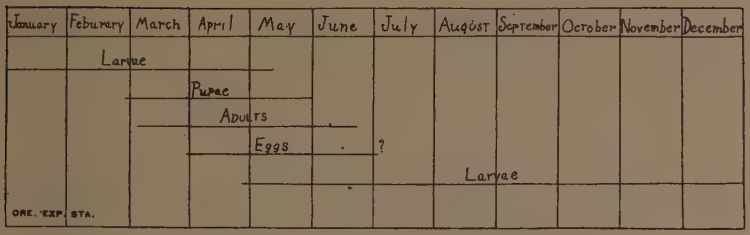


Fig. 3. Diagram showing life cycle of *Syneta albida*. (Original.)

on apple, prune, cherry, pear, quince, peach, plum, wild crabapple, hawthorn, currant, gooseberry, and hazelnut trees in about the same proportion. Other deciduous trees are fed upon to some extent, willow sometimes quite commonly.

Methods of Control.

Cultural Methods do not at the present time appear to be of any avail. Indeed the insects seem to prefer cultivated to uncultivated ground, and soon after hatching they penetrate to the soil below the plowed area. Such a thing as turning the larvae or pupae to the surface during the winter and early spring months is rather out of the question on account of the depths to which they penetrate. Keeping the orchard in sod might serve to discourage egg deposition, but this practice might not prove desirable for the best development of the trees.

Spraying. Up to the present time we have not found spraying to be profitable, because without exception we have found the injury insufficient in any orchard to warrant the cost of an application of spray that would destroy the beetles. According to the reports of growers, however, the insect is causing more damage each year and some of the growers feel that they should spray for it.

Arsenate of lead in ordinary strength is not sufficient to be of much value. In strengths of four pounds to 50 gallons of water this material will kill the beetles if they eat it, but it has been noticed that upon sprayed trees they avoid parts heavily coated, and tend to work more in the newly opening buds. If this spray is applied in the case of apples it may be put on with the pink scab spray. In the case of pears, cherries, and other fruits, it should be put on just after the petals fall.

Lime-sulfur and Bordeaux mixture are more or less useful as deterrents, but not sufficiently so to warrant practical applications for control of this pest. Young grafts may be covered with cheese cloth sacks from April to the middle of June.

Bibliography.

1893 Koebele, Albert. U. S. Dept. Agr. Bur. Ent. Bul. 32, O. S., p. 35.
188? Leconte, Dr. John T. U. S. P. R. R. Exp. and Survey, Zoology, 47th Parallel Report on Coleoptera Collected.
1892 Riley, C. V. Insect Life IV, p. 352. Reply to correspondent from Oregon.
1913 Wilson, H. F. Biennial Crop Pest and Hort. Report for 1911-12. Ore. Exp Sta., p. 160. A few notes on life-history and remedies.

THE BUD MOTH.

Tmetocera ocellana Schiff.

By H. F. WILSON AND G. F. MOZNETTE.

History.

Since this pest was known for a great many years in Europe prior to the time when it was found in America, it is undoubtedly a native of the eastern continent, having been introduced into America some time prior to 1840, when it was reported from Massachusetts by one of the earlier American entomologi-

Fig. 4. Leaf injury by the Bud Moth (*Tmetocera ocellana*). (Original.)

ical workers. In our entomological publications we note from time to time reports of this insect in both Canada and the United States; and from the fact that the pest is found in all the Atlantic and Pacific Coast states, as well as in the Central states, we judge it to be more or less injurious in all the fruit sections of America. Records in this department show its distribution throughout Oregon, Western Washington, and British Columbia.

Nature and Extent of Injury.

Beginning about the first of April every year, numerous inquiries are sent in to this office regarding an insect that eats into the opening flower and leaf buds of pear, apple, prune, cherry, etc. If the insect itself is found, it is usually described as a chocolate-colored "worm." These "worms" do not all appear at the same time; usually the emergence from the winter cocoons covers a period of several weeks.

The young larvae feed on the tissues inside the bud, the resulting injury frequently stopping further development. Oftentimes a short tunnel is made in the center of the shoot itself, causing the twig to die back for several inches. Such injury is occasionally taken for fire blight. The later appearing larvae do not burrow in at the base of the buds, but work into the center of opening buds and mat them together with silken threads. As more food is desired, the adjoining flowers and leaves are fastened in a nest within which the insects remain when not feeding.

The partly eaten leaves and flowers soon turn brown, and by this and other means the nests of the larvae are readily distinguished on the trees. This injury does not attract nearly as much attention on the old trees as it does on trees one-, two-, and three-years old. In the old trees all of the injured twigs can be pruned out, but on young trees one or more of the main branches may be sufficiently injured to spoil the uniformity of the head.

Fig. 5. Nest of bud moth made between apple and leaf. (Original.)

The larvae, which appear in the spring, reach maturity and develop into moths along in June. The eggs are laid in June and July and the young larvae begin to hatch in July. At this time, instead of gathering the leaves together in a nest, they feed on the underside of the leaf next to the main rib and larger veins. The upper surface of the leaf is not eaten, and the leaf surface soon turns brown. In September, the larvae all make their way to the twigs and build cocoons, in which they hibernate during the winter. At Corvallis we have but a single generation each year.

Life-History and Habits.

The orchardist ordinarily only finds one stage of this insect and that is usually the larva. But before the appearance of this stage we must have the adults and the eggs.

The Eggs (Fig. 6) are deposited as early as June 24, at Corvallis, and unhatched eggs may be found up to the first week in August. We do not know how many eggs a single female will deposit, and it is very likely that quite a number of eggs are not fertile, since we have kept eggs in breeding cages for some time without any change in their appearance.

When first deposited, the eggs are translucent white and so closely resemble the eggs of the codling moth that they might easily be mistaken for them. They are quite flat and oval in outline, the edges being pasted down so as to form a flat rim clear around the main portion of the egg. They measure about .8 mm. in diameter, making it necessary to use a lens in order to detect the developing larvae. About a week after the eggs are deposited, each larva takes definite shape in the egg sac, when its black head and curved outline can be seen. At the end of about 10 days, the larva is developed in the egg, and cutting a hole in the shell it crawls from the egg out onto the leaf surface, where it begins feeding almost immediately.

The Larvae. (Fig. 6). At the time of hatching, the young larvae are whitish, but they soon change to yellow and then to a chocolate-brown. Soon after hatching they begin to search for a suitable place to feed and to construct a web. In nearly all instances the main rib, or one of its larger branches, is chosen and the insect feeds partly in the rib and partly in the leaf. After

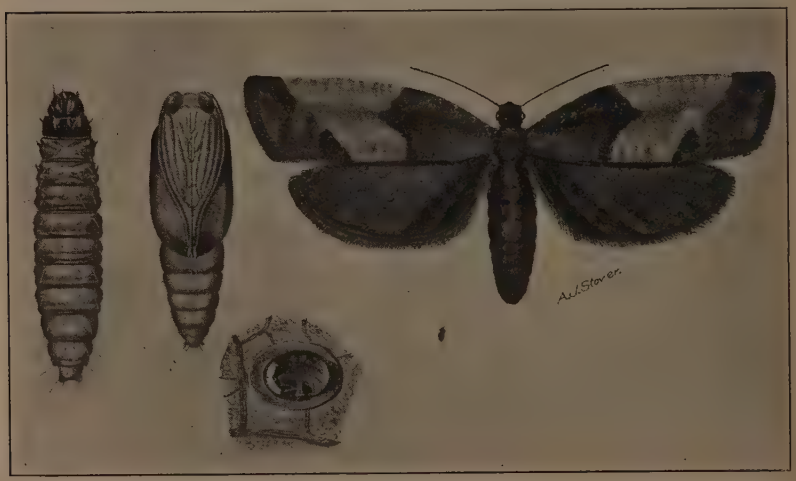


Fig. 6. The Bud Moth (*Tmetocera ocellana*). Showing egg, larva, pupa, and adult. (Original.)

several hours of feeding and resting, the young larvae each construct for themselves a silken tube, open at both ends and resting parallel to the vein. This serves as a nest or place of protection when they are not feeding. As the larvae feed and develop, the tubes are enlarged and lengthened, so that they assume more or less of a trumpet shape. In some cases the outer third of the tube may be constructed at right angles to the other part. This usually occurs at the junction of two large veins. The food is taken from the underside of the leaf, and consists of the lower surface and the tissues of the leaf, except the upper epidermis and the veins.

The area over which the larvae feed adjoins the nest and is covered with a silken web which they construct from time to time during the feeding periods. This web is ordinarily composed of white threads, but as the excrement of the larvae collects in it, the appearance changes to a black or dirty color. The larvae continue feeding on the leaves through July and August. In 1913 about 15% of the larvae were still on the leaves September 20. During the midsummer period, they molt three times, and at the time of hibernation measure about 5 mm. in length.

Hibernation. About September 1, some unknown force leads the larvae to begin abandoning the summer nests, and after that time empty nests can be found in numbers increasing each day until October 1, when few if any larvae can be found on the leaves. They seem to have entirely disappeared. A careful search on the smaller branches, however, will reveal a number of leather-colored cocoons covered with bits of bark and excrement. Each one contains a bud-moth larva. These are indicated in Fig. 8. In the majority of cases the over-winter cocoons are constructed in the angles beside or below the bud. Sometimes a cocoon may be found on each side of the bud and in the angles formed by the bud against the branches. One may also expect to find them in any spot in the bark where a rough place occurs.

At the time when the larvae enter the over-winter cocoons, some of them must be ready for the fourth molt; since we have found what appeared like cast skins in a few cocoons, we believe that occasionally the molt may occur in the

Fig. 7. Larval nests of Bud Moth. Left, natural size; right, enlarged. (Original.)

cocoon. The larvae remain in these cocoons until the following spring, when they emerge just about the time the buds are opening. April 19, 1913, young larvae, 5 to 6 mm. in length, were found just starting into the buds. In all cases they had worked in from the top of the bud. March 20, 1914, some larvae had entered the buds. The number of molts has been determined as seven, the seventh occurring with the change from larva to pupa about June 1 to June 30. Very few larvae were found on June 20, the great majority of them having already pupated.

The Mature Larvae measure 12 mm. in length and are chocolate-brown in color; head and thoracic shield shining black. The entire body is sparsely covered with light-colored hairs that arise from dark, elevated spots.

The Pupae. (Fig. 6). When the larvae reach full development they do not leave the spring nests to pupate, but construct a sort of protective web on the inner side, and shedding the skin for the last time, appear in the pupal form. In this stage the insect does not have legs, wings, or mouth parts, and does not take any food. A careful observation of this stage will show the outlined wings, legs, and sucking mouth parts that are developing inside the pupal skin.

The pupae measure about 7 mm. in length and are light brown in color. Each segment of the abdomen bears two rows of small tooth-like spines on the top side. The last segment bears a pair of hook-like bristles which extend backward. After remaining in this stage for about nine to 12 days, the pupae force their way partly out of the nest; the skin splits along the back; and the adults emerge. After resting a short time in order to allow the wings to spread and harden, they begin flying about presumably in search of food or their mates.

The Adult is a small ash-gray moth with white markings. The front wings are crossed with a wide band of dusky white. The hind wings are mouse-gray in color and the short, soft wing scales give them the appearance of plush. The end of each front wing, and the entire edge of each hind wing, have a fringe of fine hairs. When at rest, the adult measures about 7 mm. in length, with a wing expanse of approximately 13 mm.

The males and females resemble each other quite closely in all respects except the abdomen. The abdomen of the male is much narrower than that of the female, which becomes enlarged with the development of eggs. The moths move about mostly at night and lay their eggs during that period. During the day, they remain at rest on the trees, and as they resemble the bark quite closely they are rarely seen.

Fig. 8. Over-winter cocoon of Bud Moth as found at base of buds. (Original.)

Methods of Control.

It is practically impossible to try to combat this insect except in the larval stage. As in the case of the codling moth and other insects, there are times when the larvae can be more easily destroyed than at other times. The fact that they feed on the leaves all through the larval stage would seem to simplify matters, and a spray applied to the foliage any time after the larvae begin feeding should be sufficient. Since they feed inside of nests and under webs on the leaves, however, it is not easy to poison them.

The ideal time to spray would be in the middle of the summer just after the larvae hatch and before they form their tubes. If they were poisoned at that time, then there would be no injury whatever to foliage in the summer, and the larvae would not be present the following spring to injure the buds. We have noticed that even in orchards that are very carefully sprayed with arsenate of

lead in the spring, a great many of the larvae reach maturity. In orchards that have been sprayed about September 1, for late codling moth infestation, we have noticed that the bud moth is markedly less prevalent than in orchards not sprayed at that time.

The grower, then, has a choice of three spraying periods; first, in the spring; second, in the summer; third, about September 1. In the case of apples and pears, the sprays as applied for the codling moth should be sufficient for the control of the bud moth, if thoroughly applied to the foliage so as to get the spray on the underside of the leaves. The application made about June 25 for the first generation codling moth, and August 1 to 10 for the second, should be the best. On cherry trees it is usually necessary to spray for slugs, both the first and second generations. If arsenate of lead is used, it should be applied to the under as well as to the upper surface of the leaves. A great many larvae can be poisoned by these applications, but in some instances it may be necessary to make the special spring application. In general, we believe that more good can be secured from an application made September 1. This applies to all kinds of fruit trees.

Natural Enemies.

Mr. G. F. Moznette has collected three enemies of the bud moth. One was an undetermined carabid beetle which was found feeding on the larvae. An undetermined species of Triphleps was another, and the third was a mite determined by Dr. H. E. Ewing as *Anystis agitis* Banks.

Spraying Experiments.

The following experiments were carried on to ascertain whether the spray solutions employed could be used against the winter or hibernating stage of the bud moth. On February 28, 1914, four large apple trees were sprayed in an apple orchard near the College cherry orchard (Meeker orchard). Two were sprayed with distillate oil emulsion, 10 to 100, and two with Yel-Ros, 5 to 100. The trees are large and the plat is uncared for. Eight cherry trees in the College plat were also sprayed, four trees with each of the above spray solutions. The weather was fair with heavy dew. The day following, February 29, 1914, it rained most of the day. No buds were out.

On March 14, 1914, one large apple tree in the same plat was sprayed with crude oil emulsion, 10 to 100. Checks were kept in all cases. The day was fair, with a few occasional drops of rain, but not enough to interfere with the spraying. The buds were out here a little and showed some green. Four cherry trees were also sprayed.

During this time other experiments were being conducted, and in one case where the same oil sprays were applied a number of times on apple trees in the College orchard, the trees were examined and a count made. In this experiment the distillate oil emulsion and the Yel-Ros spray were applied ten times at weekly intervals, while the crude oil emulsion was applied but five times at weekly intervals. The distillate oil and Yel-Ros sprays were applied before the buds came out. No apparent injury was noted. In the case where the distillate oil emulsion was applied, it killed the grass beneath the tree. As the crude oil emulsion was applied while the buds were unfolding, the spray caused some slight injury at the time by burning the tender leaves. This spray imparts an oily appearance to the trees.

As a result of these experiments, we are led to believe that the oil sprays as ordinarily used are not efficient against the bud moth.

Table 1. Results of Spraying for the Bud Moth, Corvallis, Oregon, April 15, 1914.

Oils furnished by Balfour, Guthrie & Co.

Tree and Exp. No.	Spray solution	Date applied	Injury	Number buds infested	Number not infested	Number buds examined	Percentage infested	Remarks
1 (exp. 1)	Yel-Ros (5-100)	Jan. 10, 1914, and 9 succeeding times at weekly intervals	No apparent injury	44	455	499	8.81	Apple. West of house (Meeker) Newtown.
1 (exp. 2)	Yel-Ros (5-100)	Feb. 28, 1914, once	do.	72	419	491	14.66	Apple. Plat N. W. of College cherry plat.
2 (exp. 3)	Yel-Ros (5-100)	Feb. 28, 1914, once	do.	4	246	250	1.60	Cherry tree, small. College plat.
2 (exp. 1)	Distillate oil emulsion (10-100)	Jan. 10, 1914, and 9 succeeding times at weekly intervals	do.	9	493	502	1.79	Apple. West of house (Meeker) Newtown.
2 (exp. 2)	Distillate oil emulsion (10-100)	Feb. 28, 1914, once	do.	35	431	466	7.59	Apple. Plat N. W. of College cherry plat.
3 (exp. 3)	Distillate oil emulsion (10-100)	Feb. 28, 1914	do.	3	330	333	.900	Cherry tree, small. Cherry plat.
3 (exp. 1)	Crude oil emulsion (10-100)	Mar. 4, 1914, and 4 succeeding times at weekly intervals	Slight to foliage	1	493	494	.202	Apple. East of house (Meeker)
3 (exp. 2)	Crude oil emulsion (10-100)	Mar. 4, 1914	do.	79	445	524	15.07	Apple. Plat N. W. of College cherry plat.
4 (exp. 3)	Crude oil emulsion (10-100)	Mar. 7, 1914	No apparent injury	9	270	279	3.22	Cherry tree, small. Cherry plat.
4 (exp. 1)	Check		do.	23	478	501	4.59	Apple. East of house (Meeker).
5 (exp. 1)	Check		do.	45	476	521	8.63	Apple. West of house (Meeker)
4 (exp. 2)	Check		do.	103	379	482	21.36	Apple. Plat N. W. of College cherry plat.
1 (exp. 3)	Check		do.	16	242	258	6.20	Cherry, small. College cherry plat.

THE FRUIT TREE LEAF ROLLER.

Archips argysophila Walker.

By H. F. WILSON.

It is not known how long this pest has been present in the Northwest, but as it is found quite generally distributed throughout the Willamette Valley, the fruit-growing sections surrounding Hood River, The Dalles, Mosier, etc., the indications are that it has been with us for a long time. The larvae were first noticed by members of this department in 1911 and since that time all stages have been collected.

In general, the life-history is about the same as in other sections from which this species has been reported. Numerous reports have come in during the last two seasons with regard to a green worm found eating holes in the young fruit. The growers also state that ordinary applications of arsenate of lead

Fig. 9. Young apples injured by the Fruit Tree Leaf Roller (*Archips argysophila*.) (Original.)

as applied for the codling moth, do not seem to have been effective. As the inquiries are becoming more numerous each season, this preliminary report is given to meet the requests of the growers interested.

So far, in our observations, we have only been able to secure the eggs and rear the adults under laboratory conditions. These results, compared from time to time with conditions in the field, indicate that in Oregon there is but a single generation, and that the life-history is practically the same as in New York State.

Nature and Extent of Injury.

Up to the present time, this insect has not been as serious a pest in Oregon as in Colorado, California, and New York, and apparently the most damage here is done to the fruit. The larvae have been observed feeding in the buds in a manner similar to the bud moth, but the damage to those parts is not as serious because they leave the buds at an early date, and, confining themselves to individual leaves, roll them over, and fasten them with silken threads. This serves as a nest or hiding place. The damage to the fruit is very serious indeed, since large holes may be eaten out by the larvae, thus causing a cull in almost every instance. A single individual usually destroys a number of fruits in this way, for they move about more or less and attack different fruits during their feeding periods.

Fig. 10. Apples showing scars caused by leaf roller injury. (Original.)

Life-History.

The Eggs are deposited on the trees in June and do not hatch until April and May of the following year. The egg stage lasts for approximately nine or 10 months. They are laid in masses varying in number from 25 to 150. After being deposited, the egg masses are covered with a dark colored substance which causes them to blend with the bark so as to be almost indistinguishable. The

masses average about 5 mm. square, and may be deposited anywhere from the trunks to the tips of the smallest shoots. They are more easily distinguished after the emergence of the larvae, on account of the emergence holes.

The Young Larvae are mature in the eggshells some time before conditions are favorable for emergence, and the first warm weather at the time when the buds are opening may bring them out. The larvae, at the time of hatching, measure about 1.5 mm. in length and are dirty yellow in color, except the head which is black. From the first, the larvae are quite active and wriggle about, with quick jerks when disturbed. If a bud or folded leaf in which they have constructed their nest is opened, they quickly wriggle out and hang suspended by a silken thread. There seems to be a great variation in the time required for development from hatching to pupation. Some writers give 18 to 20 days, while another gives 30 or more days as the required time.

Fig. 11. The Fruit Tree Leaf Roller (*Archips argyrophila*). Showing the egg mass, larva, pupa, and adult. (Original.)

The Mature Larvae measure from $^9/_{10}$ to a little over 1 inch in length. The anterior two-thirds of the body is dark green, the posterior one-third yellowish-green. The head is shining black, with the segment back of the head having a light green border. Beginning with the second segment back of the head, each one bears a number of round, white discs with a single hair arising from the center. The first two of these segments bear four dots in a transverse line; the segments back of these each bear four dorsal discs forming a square. In addition to these, each segment bears two more on each side, making eight in all on top and sides of each. The feet are shining black; the last prolegs and end segment are yellow.

The Pupae. When ready to pupate the larva does not leave the nest but spins up a few more threads, casts its skin, and the pupa is formed. In this stage the insect measures about 7 mm. to 12 mm. in length and is light brown in color, with the underside shaded with green. The top of each abdominal segment is fitted with two rows of saw-like spines that point backward. On the middle segments these spines are quite prominent, while on the more distant ones they are not so well developed. The pupal stage is said to last from nine to 12 days.

The Adult is a dark, rusty-red moth variegated with obscure silvery patches and each front wing bearing two bright spots on the upper surface. Some are darker than others in general color, and it is possible to secure two adults from the same egg cluster that do not resemble each other in color at all. They emerge during June, at which time the males and females copulate and the egg masses are produced.

Methods of Control.

In this State our observations show that a majority of the egg masses are formed on the smaller branches and twigs and that a great many are disposed of by winter pruning. Enough are left on the trees, however, to cause serious

trouble sometimes, and it may become necessary to make regular spray applications.

The habits of this insect seem to make applications of arsenicals less valuable than for other leaf-eating caterpillars, and following the reports of other workers, two orchards in the Hood River Valley were sprayed early in the spring of 1914, with crude oil emulsion. The success of these applications was very marked, since very few larvae were found in the oil-sprayed orchards, while those adjoining were badly infested, in spite of the codling moth applications of arsenate of lead.

As a result of our investigations, and those of other entomological workers, the following recommendations are made:

1. Spray with a 10% solution of crude oil emulsion in the spring about the time the buds are opening. If the eggs are found to be hatching earlier, it will be necessary to make the application earlier.

2. Should the oil, for any reason, fail to kill the eggs, make an application of arsenate of lead, 2 to 50, just before the blossoms open.

Important References.

1913. Gill, John B. U. S. Dept. Agr. Bur. Ent. Bul. 116, Pt. V.
1912. Gillette, C. P., and Weldon, George. Cir. 5, Office of State Entomologist, Fort Collins, Colo. An account of investigations in Colorado.
1912. Herrick, Glen W. N. Y. Agr. Exp. Sta. (Cornell) Bul. 311.
1906. Stedman, J. M. Bul. 71, Mo. Agr. Exp. Sta.

THE PEACH AND PRUNE TWIG BORER.

Anarsia lineatella Zeller.[2]

By H. F. WILSON.

A study of this insect was primarily started because of a request made by different growers for definite data on control methods. A number of growers in the different peach-growing sections of the State have claimed that lime-sulfur was not an efficient remedy against this insect. With a view to determining the truth of the matter, arrangements were made with Mr. R. W. Allen, Superintendent of the Hermiston Sub-Experiment Station, to carry on some experiments for the control of this insect. Conditions for experimentation were thought to be more desirable in that section on account of the acreage set out to peaches and apricots.

For several years occasional observations had been made on this insect in the neighborhood of Corvallis; and when summed up, they did not exactly fit in with the observations as heretofore reported. We have been and are still greatly puzzled by the different conditions which appear to exist in different sections of the State. For instance, we can find but a single generation in the College orchard, while there would appear to be two or three generations in Eastern and Southern Oregon.

Fig. 12. Shoot killed by twig miner. (Original.)

Mr. G. P. Weldon[3] has already suggested that there is but a single, long-drawn-out generation each year, which corresponds to the conditions at Corvallis, but does not meet the conditions elsewhere. In addition, Mr. W. T. Clark[4] shows three distinct generations to be present in certain districts of Cali-

[2]With the exception of the few notes as indicated, the observations recorded in this paper were made at Corvallis, Oregon. A complete report for all sections of the state should be ready for our next report.

[3]Monthly Bulletin, Cal. State Com. of Hort., Sacramento, Cal., 1914. Vol. III, No. 7.

[4]Calif. Exp. Sta., 1902. Bul. 144.

fornia. We can only account for these conditions by one or the other of three theories; namely, that the insect may be able at will to develop one, two, or three generations as the fashion demands; or that most of the individuals compose three generations, while some of them are carried over in a single generation; or that there really is only one generation which is scattered over a long period. The latter supposition would account for the existence during the winter of larvae in different sizes.

As stated, we have found but a single generation at Corvallis. The following records from correspondence give an idea of conditions in Eastern Oregon:

Hermiston, Oregon, May 13, 1913. "Larvae injuring young peaches." R. W. Allen.

Hermiston, Oregon, July 12, 1913. "What appears to be the second brood of the peach-twig borer is causing considerable trouble by attacking the peaches at the present time." R. W. Allen.

Hermiston, Oregon. July 12, 1913. "I have discovered on early variety of peaches now ripening, a bug identical with twig borer. Practically all are wormy." B. G. Monkman, M. D.

Hermiston, Oregon, April 20, 1914. "The peach-twig borers are getting in some good work in orchards that were not sprayed and some are pupating." R. W. Allen.

In September of the present year a student in Entomology brought in a number of ripe peaches with mature larvae working in them.

Nature and Extent of Injury.

The injury caused by this insect is two fold, in that it attacks the young shoots, boring down the center of the twigs, and later bores into the fruit. In both cases, if the larvae are abundant, the damage caused is very serious. In the first place, the damage to the twigs may cause a serious deformation of the tree. The damage to the fruit is sufficient to make it unfit for sale and may cause as high a loss as 75% of the crop.

Fig. 13. Larvae of twig miner in infested shoot. (Original.)

In the spring, shortly after the buds have opened and the new foliage is appearing, one may notice that from a few to many twigs are wilting and that the half-developing leaves are hanging down. Upon examination, a burrow will be found extending down the center of the twig an inch or more, and frequently a small brownish larva will be present. At other times the signs of depredation cannot be found and the burrow will be filled with gum. The reason for this is the fact that each larva may attack and feed on a great number of twigs, for they have a great inclination to wander about; and the disturbing of a twig in which a larva is present usually causes the larva to leave its burrow for a new one.

In many cases every twig toward the tips of the branches may be destroyed, including the terminal bud. This condition causes the branch to die back for a considerable distance and an abundance of new, weak, and undesirable shoots to sprout out just below the injured part. The location of the injured buds is indicated later in the summer only by little "nubbins," which formed the bases of the buds. An example of injury to an old and a young tree is shown in Fig. 14a and b.

The injury to the fruit is caused by the larvae eating out pockets just below the surface. The larva nearly always enters at the stem end, although occasionally one may enter where two fruits touch and may even work in both of them. In entering the fruit, the larva makes a hole in the skin and then works through into the pulp, feeding as it goes. Beneath the skin a chamber or pocket is formed, which usually contains a filthy mass of gum mixed with excrement. That portion of the skin covering the burrow has a dark sunken appearance, and soon becomes decayed. Frequently the larvae in ripe fruit bore down around the pit and when the pit splits, they work their way into the center. The writer does not believe that the insect causes the splitting of the pit or seed.

Fig. 14. Photographs showing: A, eight-year-old tree; and B, a four- or five-year-old tree injured by the twig miner; C, tree in same plat with B, sprayed with lime-sulfur in spring. (Original.)

Life-History.

With our present incomplete knowledge of this insect's habits, the writer is not in a position to say that there is but one generation, or that there are two, three, or four, as claimed by different writers. In the College orchard, up to the present time, there has undoubtedly been only a single generation a

year. This may or may not be due to the fact that the trees have not been in bearing.

The Larvae. In this locality the larvae may be found in the hibernating burrows from late June till April or May of the year following, and we have not been able to find the mature larvae of the second and third generations as they appear in other sections. This condition has already been noted by Weldon.[5]

Shortly after hatching from the eggs, the young larvae crawl down to the rough bark in the crotches of twigs and limbs and burrow down into the bark, apparently doing some feeding as they go; for they develop from about 1.5 mm. to about 2 mm. in length during the time that the burrow is being constructed. Prof. W. T. Clark has described the hibernation burrow quite thoroughly and his statements are borne out by our observations. In constructing the burrow, the young larva weaves a silken tube, lined on the outside with pellets of frass. The purpose of this tube is not known. The tube leads directly into the burrow itself, which is hollowed out just below the outer layer of bark and lined with silk. Occasionally a silken partition is constructed across the tube at or above its base. The tubes are easily located in the crotches by means of a hand lens.

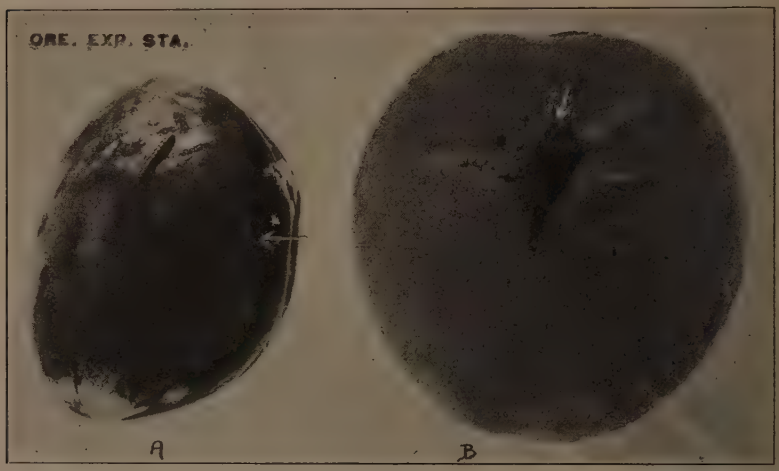


Fig. 15. A, a larva of the Peach Twig Miner on prune, removed from wound at arrow point. B, peach showing wound made by twig miner, pupa shown at edge of wound. (Original.)

During the late summer and winter months, the larvae apparently do not feed, as they do not increase any in size. In the spring shortly before emergence, they cut an opening through the bark at some point distant from the main tube and tiny piles of frass and excrement are thrown out. At the same time, the larvae begin to increase slightly in size, and when they emerge, they measure about 3.5 mm. in length. At this stage the larvae are chocolate-brown with the head and anal plate shining black. Upon leaving the over-winter burrows, the larvae crawl to the base of a bud or in between the opening leaves and begin to eat their way in and down through the center of the twig.

Very few if any of these larvae remain in the original twig, but wander about from twig to twig and feed a little in each one. When the larvae are mature and ready to pupate, they do not immediately leave the last burrow, but may remain there for a number of days resting. When ready to pupate, they may or may not leave the burrow and a great many of them pupate in the dead leaves found fastened at the tip of the twig. Some undoubtedly scatter out

[5] See Note 3.

over the tree and pupate under pieces of bark, etc. We have not been able to observe any of these.

The mature larvae measure about 12 mm. in length, and all that have come under the writer's observation were chocolate-colored brown with the head and anal shield shining black.

The duration of the larval stage at Corvallis is about 10 to 11 months.

The Pupae. The pupae are brownish in color and measure about 10 mm. in length. The pupal cocoon, which is formed of loosely woven threads of white silk, affords its occupant little if any protection, simply serving to keep it in the nest of leaves. Clark writes of the same condition for the pupae that transform on the trunk. According to Cordley, the moths begin to appear in breeding cages on May 17, and continue to emerge until June 5. We have found this to be practically true, as Mr. Moznette, of this department, has recorded one pupa on May 18 in the laboratory. In the field we have not been able to find pupal forms until June 2. The pupal stage lasts from eight to 12 days.

The Adults. The adult is a moth, colored dark gray to black, with the front wings having a few dark streaks or lines. The hind wings are much lighter in color than the front wings and bear a heavier fringe along the edge. The moths which are very quick in their movements, fly about from one place to another with great rapidity when disturbed. The length of the moth when at rest is about 8.5 mm.

The Eggs. We have not had an opportunity to make extensive observations on the eggs, and did not secure the length of the egg stage. In the College orchard on July 2, 1914, eggs were found which answered the description given by Clarke. However, an outbreak of grasshoppers in the eastern part of the State compelled the writer to be away for about two weeks at that time, and the observations were sadly interrupted.

The eggs are pearly white in color, rather coarsely reticulated and change to a deep yellow or orange previous to hatching. They are oval in shape and measure about .45 mm. in length by .23 mm. in width. According to Clarke:

Fig. 16. Hibernation burrows of larva of Peach Twig Miner. (Original.)

"These eggs were generally placed on the new twigs near the bases of the leaves, and from one-half to two-thirds of the distance out from the point of beginning of the twigs. The eggs were placed lengthwise of the twigs, and in a few cases were concealed beneath the tracts at the bases of the leaves."

At Corvallis the larvae from these eggs go down and construct burrows about the crotches of the trees and do not burrow into the twigs. Other observers report that these larvae bore into the stems and after working in them for a period of several weeks, leave and enter the fruit if any is present on the tree. If no fruit is present, they continue to work in the stems.

The larvae of this generation pupate in July, and in about a week a generation of moths appears which deposit eggs on the fruit. In another week these eggs hatch out and a third generation of young larvae emerges. The larvae bore directly into the fruit, where they remain feeding for about a month. They then emerge from the fruit, pupate as before, and another generation of moths appears about the later part of August and deposits eggs. According to Clarke:

"These eggs were placed sometimes in small cracks and crannies of the bark, and sometimes quite exposed on the bark of the older wood just above the crotches formed by the new wood. The eggs hatch in about five days, and the young worms, which are from ½ to ¾ mm. in length, immediately proceed to bore into the bark of the crotches formed by the new wood with the growth of the previous year, and begin preparing their winter quarters."

At Corvallis the hibernation chambers are found in the crotches of limbs three or four years old, as well as in the new wood.

Control Methods.

Fig. 17. Larvae at rest in the hibernating burrow, Peach Twig Miner. (Original.)

Lime-sulfur, if applied at the right time, is said to be a satisfactory remedy for the peach- and prune-twig borer. Clarke, who recommends the lime-sulfur treatment, states that it should be applied in the spring just as the buds are swelling. We have found that this limitation is not necessary and that lime-sulfur is effective if applied any time in the spring up until the time the buds open. This has been especially borne out in the Hermiston section, where sprayed orchards adjoining unsprayed areas have been free from injury, while the unsprayed orchards were seriously damaged.

In 1914 a series of experiments was carried on in the peach orchard of the Hermiston sub-station to determine the relative values of lime-sulfur, Black Leaf-40, and arsenate of lead, alone and in combination. These applications were made in April, and the results obtained are shown in Table II.

Table II. Relative Value of Sprays in Controlling Twig Borer.

Plat	Spray	No. trees	Number buds counted	Percentage buds destroyed
1	Black Leaf-40, 1-2000	4	2,183	17.6
2	Arsenate of Lead, 2-50	4	1,370	2.4
3	Arsenate of Lead, 2-50+Black Leaf-40, 1-2000	4	1,110	1.98
4	Arsenate of Lead, 2-50+Lime-sulfur, 1-12	4	910	.10
5	Black Leaf-40, 1-2000+Lime-sulfur, 1-12	4	2,370	1.34
6	Unsprayed check	4	3,090	7.15

The percentages were secured by counting the number of infested and uninfested buds on the trees used. The work was carried on by Mr. Allen and his assistants. The photographs in Fig. 14 show best the results of spraying. A and B were unsprayed. C was taken in a plat sprayed with lime-sulfur 1 to 12 and Black Leaf-40, 1 to 2000.

AN APPLE LEAF MINER.

Phyllonorycter (*Lithocolletis*) *crataegella* Clems.

By H. F. WILSON.

This leaf-mining insect is quite common throughout the orchards of Western Oregon and is found working between the two leaf surfaces of the apple. Apparently its native food plant is the native hawthorn and wild crabapple. In Oregon it has become well established on the apple, and hundreds of leaves on a single tree may have from one to a dozen mines. Just how much injury results from the work of this insect cannot be estimated. We cannot see that the fruit or trees have suffered in any appreciable degree, although the vitality of the trees certainly must be decreased more or less.

The Mines vary considerably in size and do not appear to be formed along any regular lines, except that they are always included between two of the larger cross veins. The upper side of the mine is indicated by a dead brownish area which results from the larvae eating away everything but the upper epidermis. The lower side of the mine is noted as a brownish or yellowish spot with the lower epidermis drawn and wrinkled. The contraction of this surface causes a slight folding of the leaf.

Fig. 18. A, apple leaf showing nest of miner; B, larva of miner in nest with the lower surface removed.

Life-History.

The number of generations a year is not definitely known; but there are probably two. This supposition being correct, the winter is spent in the pupal stage and the adults emerge in the spring. They then copulate, and the females lay their eggs on the leaves, possibly on the underside. The young larvae hatch out and, working beneath the epidermis, spin a web over the lower side of the

mine, which probably draws the lower surface into wrinkles. The food is then taken from the upper tissues clear to the epidermis.

When ready to pupate, the insect constructs a silken cocoon around itself, molts for the last time, and appears in the pupal stage. After remaining in this stage for a certain unknown period, the adult, a tiny, silvery moth, appears. These moths then lay eggs and a second generation comes on, the pupae of which are the over-winter forms. The first generation, including all stages from egg to adult, lasts from spring to about August, the second generation beginning in August. The larval stages last up to late fall and the pupae are formed in October, November, and December.

The Larvae are lemon-yellow in color, with a brown band extending from the base of the second to the base of the tenth body segment. The mandibles and fore part of the head are dusky. Each body segment is furnished with about six long hairs and under the microscope the body may be seen to be covered with numerous tiny spines.

The Pupae are formed inside a silken cocoon within the mine. They are brownish in color with the base of each body segment dirty yellow. The head and thorax are shining; the body segments are dull, the anterior half being covered with numerous short spines. The basal portions are strongly carinated. Each segment also bears on the sides two small hair-bearing tubercles.

The Adult is described by Dr. Clemens as follows:

"**L. crataegella.** Antennae, front and tuft dark silvery-gray. Fore wings rather deep brownish-golden, with a broad silvery basal streak, black-margined toward the costa, extended to the tegulae in front and pointed behind, with the point black-margined on both sides and with the costa black. Four costal silvery streaks, the first oblique but rounded beneath and black-margined on both sides, the others toward the base alone. Three silvery dorsal streaks, the first rather broad, oblique, nearly touching the first costal, and black-margined on both sides, as also the second; the third only toward the base. A streak of black scales in the middle of the wing at the apex, extended backwards between the streaks to the second dorsal and costal. Hinder-marginal line blackish, with a violet metallic hue; cilia dark fulvous."

Control Measures.

Control measures, so far as known at present, consist of plowing the dead leaves under so as to bury the pupae deep enough to prevent the adults from emerging from the ground. Spraying has not been tested out sufficiently to warrant definite recommendations along that line. Arsenate of lead, applied to the lower surface of the foliage, may prove efficient to a more or less degree. We do not believe, however, that the problem is serious enough at this time to warrant special applications of spray.

A NEW CHERRY PEST.

Simplemphytus pacificus McGillivray.[6]

By H. F. Wilson

This pest has only recently been found in Oregon and very little is known of its life-history. During the winter of 1913, specimens were sent in from Troutdale where they were said to be causing some little damage to cherry trees. As the insect was entirely new to us, Mr. Moznette, of this department, was sent to investigate the trouble, and found that, while some damage might result from the burrows made, the insect in itself was not a serious pest.

Specimens of the adults when obtained were sent to Dr. A. D. McGillivray, of the University of Illinois, who kindly made the determination for us and explained that the members of this group bored into trees in the manner stated, for the purpose of pupating.

Nature and Extent of Injury.

Continued studies of this insect show that the larvae bore down the pith of stubs left by pruning (Fig. 19), and except in cases where the stubs are short, they do not bore below the junction of the nearest branch (Fig. 19). In cases where the stubs are longer than the pupating burrow, the insect does not work down to the first shoot. (Fig. 19). The chief danger then is from such plant diseases as may settle in the open burrow after the insect emerges.

Life-History Notes.

On account of more important problems, we have made no effort to determine the host plant of this insect, and our knowledge of it begins with its migration to the cherry stub in the fall. As the insect is always found with its head

Fig. 19. A new cherry pest (*Simplemphytes pacificus*); a, adult; b and c, larvae in winter nests of cherry stubs.

[6]"Canadian Entomologist," 1914, Vol. XLVI, p. 363.

toward the opening, and as the burrow is only slightly larger than the insect itself, the insect must of necessity make the burrow and then back into it. After turning about in the burrow, the insect, now a mature larva, constructs a partition across the burrow just beyond its head (Fig. 19). This partition appears to be made up of silk and bits of frass.

At this time the larvae measure about 10 mm. in length by about 1.5 mm. in width. They are bright green from above with a series of dark brown transverse lines along the body. They remain in the larval stage until about the last of February when pupation begins. At first the pupae are pure white with red eyes. Later the abdomen becomes greenish and the wing pads, head, and antennae white. Gradually these parts turn black, except the sutures of the abdomen, which remain white. The pupae measure about eight mm. in length. The adults emerge during March.

The Adult is described by McGillivray as follows:

"**Female.** Body coal-black, with the distal third of the front femora, the front tibiae, the front metatarsi, and the knees of the middle legs, pale rufous or whitish; the antennae short with the third segment larger than the fourth; the fourth and fifth subequal; the head, including the clypeus and labrum densely punctured and setaceous, less abundant on the postocellar area; the molar space broad; the clypeus deeply rounded emarginate; the labrum set in the emargination; the supraclypeal are elevated, convex; the antennal furrows broad depressions; indistinct, line-like marks at the occiput; the ocellar basin broad, diamond shaped, enclosing the median ocellus and extending to the median fovea, which is round, shallow, indistinct, and still less distinct in the male; the mesanotum, the metanotum, the pleurae, and the pectus polished; the abdomen polished, densely setaceous; the saw guides convex above, straight on the proximal half below, convex on the distal half, joining the upper margin at the middle of the distal end and forming a pointed but bluntly rounded distal end. Length seven to nine mm."

INJURIOUS GALL MITES.

By H. F. Wilson.

Gall mites, so called because they cause gall-like formations in buds, leaves, etc., are not generally as detrimental to plants as might seem. There are a few species, however, that may cause serious damage. Among others found in Oregon, we have four species which deserve more or less consideration at this time.

THE PEAR-LEAF BLISTER MITE.

Eriophyes pyri Pagenstetcher

These mites are microscopic in size, and can be just faintly distinguished by the unaided eye. This particular species winters about the bud scales of the plant's young growth, usually about the second or third scale from the outside. When abundant, they are found in colonies of fifty individuals or more, protected by the pubescence which is usually present. As the buds begin to swell and as the leaves open, the adult mites spread over the under surface of the leaves and each female burrows through the epidermis and into the parenchyma of the leaf, where it deposits its eggs.

Fig. 20. Pear Leaf Blister Mite injury on leaves.

Life-History

The eggs are nearly white or yellowish, and very large in comparison to the size of the mites. The larva is the same as the adult, except in size. The pupa likewise resembles the adult. In all stages the mite has only four legs, and a rather long, slender abdomen, crossed by a variable number of striae. As the young develop they extend the channels in all directions, causing the development of a corky growth. This is more apparent on the upper surface than on the under, and is at first reddish, later turning brown.

All through the season, the adult mites are leaving the galleries through minute openings, spreading over the surface of the leaf, and forming other galler-

ies with the result that by summer or fall the leaf may be a solid mass of these blisters. In such cases, the vitality of the tree is seriously impaired. The spots caused by the pear-leaf blister mite resemble very closely spots formed by various fungi, but a little examination with the lens on the under side of the leaf will reveal a small round hole leading to the home within. This is characteristic of all mite blisters. These creatures work upon the leaves not only of the pear, but the apple, hawthorne, quince and other trees. No serious injury is done to these, although a closely related species is beginning to work on the apple in the eastern United States.

Methods of Control.

The pear-leaf blister mite may be fairly well controlled by spraying. The results we have obtained in the Northwest by using the lime-sulfur spray just before the buds start, have been quite satisfactory. Probably if one were spraying for these insects alone, better results would be obtained by spraying at the time when the mites are migrating from the leaves to the buds. Experiments conducted in New York indicate that the best results are obtained by using some oil spray like Scalecide, distillate, or kerosene emulsion. We have always recommended lime-sulfur, winter strength.

THE GRAPE LEAF MITE.

Eriophyes vitis Landois

Specimens of leaves containing galls of this mite were sent in from Freewater, Oregon, during September, with a note to the effect that the vines were badly infested but apparently not suffering to any extent. Nothing is known of its life-history, but following our general knowledge of the group, the mites undoubtedly hibernate over winter as nymphs or adults about the bud scales or under loose bark. They should therefore be easily destroyed by lime-sulfur or an oil emulsion spray applied during the dormant season, or just as the buds are swelling in the spring.

Fig. 21. Grape Leaf Mite injury on leaves.

Appearance of Galls.

This species does not work between the two leaf surfaces, as in the case of the pear-leaf blister mite, but rather works on the under side of the leaf, and causes the upper surface to become distorted with a series of swellings. On the lower side of the leaf and opposite these swellings, numerous fine pubescent hairs are caused to grow, which form a felt-like layer. The color is usually a light orange brown. On account of this peculiar growth, this type of gall is commonly known as felt gall.

Control.

Lime-sulfur, applied in the spring when the buds begin to swell, should be an effective treatment.

THE WALNUT LEAF MITE.

Eriophyes tristratus, var. *erinea* Nal.

Another one of the erinose or felt mites was sent in to the office during the past summer; later this mite was found to be present in various sections of the

Fig. 22. Walnut Leaf Mite injury on leaves.

Valley on the leaves and nuts of the English walnut. As the life-history and general habits are probably the same as with the grape-leaf mite, lime-sulfur will probably prove to be an efficient remedy.

The gall formation caused by this species, while quite similar to the grape-leaf mite, and with the same felt-like appearance, is sufficiently different to be quite distinct. The swellings on the upper side of the leaves are the same, but the lower surfaces are not as abundantly supplied with felt, which is white instead of brown. The galled areas are also more distinctly outlined with this mite and the small cross veins form distinct cross ridges between the larger veins. See Fig. 22 for photograph of specimen.

Lime-sulfur applied in spring when the buds begin to swell should be an effective treatment.

THE FILBERT BUD MITE.

Eriophyes avellenae Nalepa.

This mite has also not been previously reported from Oregon, and on account of the manner in which it works and the time when migration takes place, it is likely to prove a very serious pest in this State. Samples of infested buds were first brought in by Prof. H. P. Barss, who collected them at Springfield, Oregon, on cultivated filberts. The gall formed is a bud gall in this case, and from the fact that apparently all of the buds are attacked, the indication is that the grower will have a very formidable enemy to deal with should the infestation become general. The galls may be found at all times during the year, but are less in evidence during the later part of the summer, since the mites are said to emigrate from the old buds to the new during the middle of the summer. By causing the gall formation, the growth of the buds attacked is destroyed and the leaves and catkins do not unfold.

No efforts have been made to determine a remedy, but on account of the mites being protected by the bud scales, winter treatment is not likely to prove effective. For example of injury, see Fig. 23.

Fig. 22. Filbert Bud Mite injury. The buds on the two shoots at the left have become galled. The buds on the three shoots at the right are normal.

INSECT PESTS OF STORED PRODUCTS.

By H. F. Wilson.

Agricultural products are not only destroyed by insect pests in the field, but are subject to attack in the storehouse after having been gathered. Especially is this true where such products remain in storage for a considerable length of time. The materials commonly attacked are dried fruits, vegetables, grains, cereals and nuts.

A number of these pests are now present in Oregon and some of them are causing noticeable damage. Of these, the Indian meal moth (*Plodia interpunctella* Huebn.), and the saw-toothed grain beetle (*Silvanus surinamensis* Linn.) are the most important.

THE INDIAN MEAL MOTH.

Plodia interpunctella Huebn

During the past two years this insect has been brought to our attention through its depredations on stored products of various kinds, principally walnuts and dried prunes. Ordinarily it may be found feeding upon all kinds of stored products, such as grains, cereals, flours, dried fruits, nuts, etc. The evidence of the fondness of this insect for various kinds of meals is shown in the common name applied to it.

As a pest of walnuts and dried prunes, we have had evidence that considerable loss is liable to be caused by a single sack of infested walnuts or box of prunes being carried into an uninfested storehouse. Infestation is spread very rapidly and a hundred-pound sack of nuts may be destroyed in a short time. The shell seems to be of little protective value, as the larvae eat holes through the shells at all points, and the adults emerge from the whole nuts about as rapidly as from cracked nuts. In most cases the pupal stage is found inside the nut.

The principal injury to nuts and dried fruits comes through the feeding of the larvae. They feed in and upon the edible parts, and soon make those parts unsightly and undesirable for food by spinning silken threads and leaving castings and excrement behind them. As they move about over their food, many small particles of food are cut off and fastened together with pieces of excrement, so that the amount eaten is only a small part of that made unfit for use.

Life-History

Under conditions in which we have found this insect working, there is a continuous development throughout the year and generation follows generation, numbering from three to five or more, depending upon conditions of temperature and food supply. The eggs are deposited on whatever may be chosen for that purpose by the female and do not seem to be placed with any degree of regularity. They may be found singly or in groups, and in our breeding cages they were frequently found on the sides of the breeding cages and on the cloth covering at the top.

The Eggs are pearly white in color and flattened ovoid in shape. They measure 0.5 mm. in length by 0.3 mm. to 0.35 mm. across, depending upon whether they are deposited in a depression or on a flat surface. The surface of the egg is rough and has a dull, lustry appearance. Chittenden reports that as high as 350 eggs may be deposited by a single female. We have observed as high as 298.

To determine the effect of temperature on the eggs, some were kept in a vault in the center of the Agricultural building and others were kept in the laboratory. Those in the vault required from 11 to 13 days to hatch, while those in the laboratory hatched in from three to eight days.

The Larvae, immediately upon hatching, begin crawling about in search of food and a hiding place. Usually three or four days after they start feeding, they spin a scout web over or about their home, which soon becomes a dirty looking, filthy mass formed by interwoven pieces of food and excrement. The

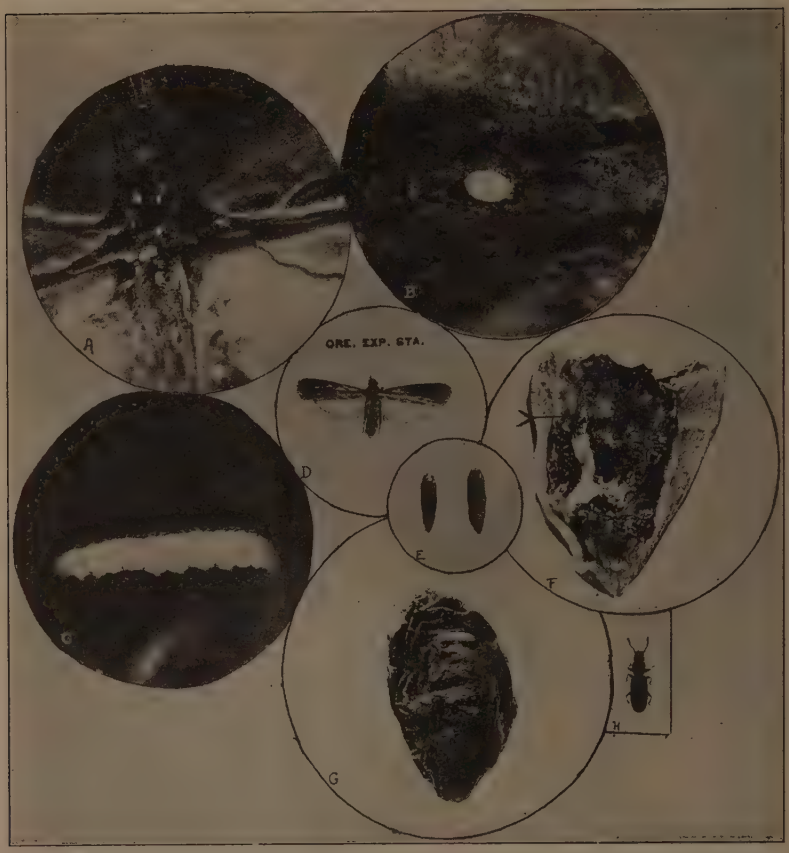


Fig. 24. The Indian Meal Moth (*Plodia interpunctella*); a, eggs on walnut; b, egg much enlarged; c, larva; d, adult; e, pupa; f, pupa in piece of walnut shell; g, larva on prune; h, the Saw-toothed Grain Beetle.

length of the larval instars varies greatly even with the same conditions of temperature and food supply. We have found that the entire period ranges from 40 to 80 days, with an average of 60 days. In all, the larvae molt six times. The first instar requires from 9½ to 16 or more days; the second, 7½ to 10 or more; the third, four to nine or more; the fourth, six to 14 or more; the fifth, six to 12; the sixth, eight to 18 days.

When first hatched, the larvae measure about one millimeter in length and are pale greenish-yellow with a brownish head. When mature, the larvae measure from 12 mm. to 13 mm. in length and are light greenish-yellow in color with varying tints of pink or darker green. The head and thoracic shield are brown. The entire body is sparsely set with long, slender, whitish hairs.

The Pupa is brownish in color. From 11 to 17 or more days are required for the pupal stage.

The Adult Moth, when at rest, measures from 9.5 mm. to 12 mm. in length.

and the wing expanse is from 12 mm. to 19mm. In color they appear dirty gray with the outer two-thirds of the front wings having a coppery metallic lustre. After emergence the adults live through a period of about 7½ days for the males, and 10 to 15 days for the females. The period of egg deposition lasts from 9½ to 15 days, the female moths dying from one-half to a day after the last eggs are laid. As high as 115 eggs may be deposited the first day after copulation is completed. Not more than fifty have been found on any succeeding day. Complete copulation may last from 12 to 24 hours.

Combative Measures.

Combative measures consist of, first, keeping materials that are likely to become infested in insect-tight boxes or bins in dry, cool rooms. If vegetable foods, such as flour, corn meal, breakfast food, etc., become infested or are found to be infested when received from the store, place immediately in the oven and heat to about 125° F. Care should be taken not to allow the temperature to go above 150° F., as the materials may be seriously injured with greater heat. The materials may then be sifted and the dead insects taken out.

For dwellings, store rooms, packing houses, etc., fumigation or dry heat should be used for complete destruction of the pest. In order that the fumigation may be successful, the rooms to be fumigated should be as near air tight as possible to prevent the escape of the gas and a lessening of its efficiency. The materials ordinarily used for fumigation purposes are hydrocyanic acid gas and carbon bisulfide. The first material is extremely deadly and should only be used under the direct supervision of someone familiar with its use.[7]

Carbon bisulfide is somewhat dangerous, especially as it is explosive, but with ordinary precautions to keep away fire, matches, lighted cigars, etc., there is little or no danger. As this gas is heavier than air and works for the most part downward, it should be placed in pans or dishes near the top of the bin or room to be fumigated. The amount of material necessary for successful fumigation will depend a great deal upon the temperature. In no case should the fumigation be carried on below a temperature of 65° F., as the gas does not seem to be effective below that temperature. At ordinary temperature four pounds is sufficient for 1000 cubic feet of space.

THE SAW-TOOTHED GRAIN BEETLE.

Silvanus surinamensis Linn.

Many inquiries have recently been sent in about this insect, which is reported as doing damage to oats, barley, wheat, stored prunes, etc.

The winter is passed in the adult stage, and on account of the beetles' habit of crawling about through the infested materials and their brown color, they are more easily noticed at that time. The adult is a small, flattened, dark brown beetle measuring about $\frac{1}{10}$ inch in length and having the thorax with a series of sharp saw tooth-like projections on each side. Fig. 24 H.

The larvae are white in color with dark markings and are somewhat flattened. They may be found in infested material at practically all times during the summer months. Chittenden states that six or seven generations each season have been estimated for Washington, D. C.

Remedies.

The treatment applied for the Indian meal moth will be suitable for this insect.

OTHER STORED PRODUCTS PESTS.

Other pests of stored products found in Oregon are:
The square-necked grain beetle (*Cathartus gemellatus* Duv.)
The granary weevil (*Calandra granaria* Linn.)

[7] Full directions for use can be secured by writing to this department.

The rice weevil (*Calandra oryzae* Linn.)
The pea weevil (*Laria pisorum* Linn.)
The bean weevil (*Acanthoscelides obtectus* Say.)
The cigarette beetle (*Lasioderma serricorne* Fab.)
The angumois grain moth (*Sitotraga cerealella* Oliv.)
The cheese mite (*Tyroglyphus lintneri* Osborn).
The flour mite (*Tyroglyphus farinae* De Geer).

Also, a species of mite found working in refuse grain and flour, which Dr. Ewing has indicated as being a new species.

THE THISTLE BUTTERFLY.

Vanessa cardui Linn.

By H. F. WILSON.

During the season of 1914, this insect was exceedingly abundant throughout the State, working on the Russian thistle. Many inquiries have been made by farmers with the hope that an efficient means of eradicating the thistles might result from the work of the caterpillar. We do not believe that the caterpillars are ever liable to become plentiful enough to be of much value in this case, and the farmers are warned not to put any dependence upon the insect. Plants may be so badly eaten that they do not flower, but few if any are entirely destroyed, and any efforts that are being made to keep down the thistles should not be discontinued.

The Eggs of the thistle butterfly are deposited on the leaves of the thistle in the spring and the young caterpillars may be found feeding on various thistle plants about June 1. The eggs are round and strongly sculptured. They appear to be deposited on stalks or on the ends of the plant hairs of the leaf.

The Larvae (Figs. 25 A and B) are gray in color with black and purple marking which give them a mottled appearance. The head is black, and along each side of the body may be found a series of black spots which are the openings to the breathing pores. These do not occur on the first three segments following the head. Each body segment also bears a series of branched spines, which are probably for the purpose of keeping away predaceous and parasitic enemies.

The Chrysalid (Fig. 25 C) is grayish in color, sometimes tinged with pink. Along the dorsal surface of each body segment are a series of three

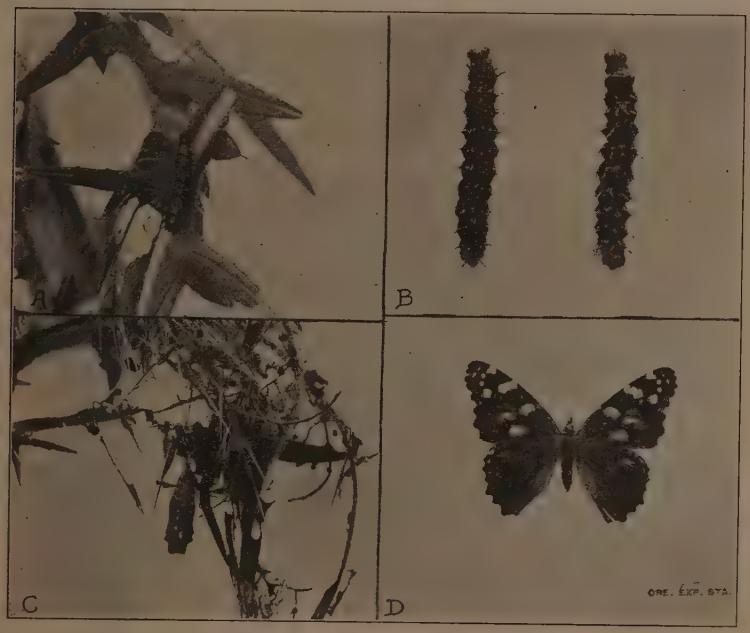


Fig. 25. The Thistle Butterfly (*Vanessa cardui*); a and b, larvae; c, chrysalid; d, adult.

golden-colored dentate tubercles; the middle tubercle is placed slightly forward of the other two. The entire body is covered with regularly-placed black dots. Two rows of these dots extend along each side of the sheath, covering the mouth parts. The chrysalid hangs downward and is attached by an elongated piece at the tip of the abdomen.

The Adult (Fig. 25 D) is predominately red in color with black areas and white markings. In the photograph the distinguishing markings are not entirely evident, as the red and black blend more or less. In the front wings, the three white patches nearest the base of the wing are light pink. The hind wings do not have white markings, except the white dashes found in the hollows of the curves along the edges. These are very indistinctly shown in the photograph. On the underside the wings are more of a mottled gray and black in appearance, the front wings having about the same markings as above, and the rear wings having no red markings. Each of the hind wings also has four eye-like spots with black centers and purple, brown, yellow and black circles or semicircles surrounding them.

There are probably two broods in Oregon, the first occurring during June, July, and early August, and the second occurring during August and September.

GRASSHOPPERS IN OREGON.

By H. F. WILSON.

Grasshopper plagues occur to some extent in all sections of the globe, but they are slight or serious, depending upon the species of grasshopper involved and the sections of the country in which they occur. During the past two seasons, several species have been extremely bad in certain sections of both Western and Eastern Oregon. Because of the more favorable conditions that have prevailed, they have caused large losses in the southern, central, and eastern parts of the State, where entire fields, many acres in extent, were made absolutely bare of vegetation.

This condition was brought about by the grain being frosted back early in the spring and when it was about four or five inches high, the young nymphs of *Camnula pellucida* and *Melanophus atlantus* migrated in; and after they had moved on, not a blade of grain was left. In hay lands, the grasshoppers developed on high ground, and as soon as the irrigation water was removed, they moved onto the more tender grass, in many cases causing a loss of from 25% to 50% of the hay crop. Large areas of pasture land have also been badly damaged in the same way.

In fruit-growing sections of the State, young orchards have been badly injured, and in a number of cases the trees were entirely stripped of their foliage. In the alfalfa-growing sections, the crop was materially reduced, and in isolated cases covering small areas, only the stems of the alfalfa remained, the leaves having been entirely eaten away.

On July 1, 1914, the writer was called to Klamath Falls, Oregon, to consult with Mr. McCall, the Klamath County Agricultural Advisor, for the purpose of determining upon a plan for destroying the migrating host which was then traveling across the fields and making great inroads upon the crops. Most of the grasshoppers present were still in the nymphal stage, but quite a number had wings. The unwinged forms were held in check on certain fields by the large drainage ditches found in that section and millions had been driven into these and destroyed.

However, there seemed to be no abatement of the trouble. A plan of campaign was therefore outlined, whereby the necessary materials for making

Fig. 26. Young apple tree stripped by grasshoppers.

up poison bran mash was secured; and a series of experiments was carried out to determine the best combination to use, with the best time and method of application. In considering the use of oranges and lemons, it was found that these were almost too expensive in the proportions recommended by the California and Kansas Experiment Stations, and so lemon extract was used in comparison with the fruit.

The following combinations were then made up for field tests:

Bran	50 pounds.
Paris green	2 pounds.
Molasses	1 quart.
Salt	1 pound.
Lemons	½ doz.

Bran	50 pounds.
Paris green	1 pound.
Salt	1 pound.
Lemon extract	1 ounce.

Bran	50 pounds.
Paris green	1 pound.
Salt	1 pound.
Molasses	1 quart.

In each case sufficient water was added to make a crumbly but not soggy mash. Later a portion of a combination made according to the first formula was also used as a soggy mass saturated with water. To determine the efficiency of these preparations, they were taken into the field and portions of each were placed upon boards in the center of the field and a careful watch kept to see what the grasshoppers would do. Within a few minutes the grasshoppers in limited numbers began to draw in toward the bait from all sides and commenced feeding. Part of those attracted crawled onto the edge of the boards but did not feed.

One specimen of *Trimerotropis vinculata* Scudder crawled up to a pile of the material and proceeded to eat a piece of the bait as large as itself. After gorging itself, it crawled away and was picked up and put in a box. The following morning this individual was dead, as were a great many others in the field where the bait was placed.

In these tests we found that one combination was about as attractive as another, except that the bait containing the lemon extract attracted a greater number in a shorter time. According to the number of grasshoppers found dead in the immediate vicinity of the bait, one pound of paris green seemed to be as efficient as two. In putting out the bait, we found that the best results were obtained by spreading it early in the morning before the dew was off the grass.

Following these experiments, which were conducted near Fort Klamath, a meeting of growers was held at Fort Klamath and the following cooperative plan was decided upon. Based upon our recommended use of ten pounds of bait broadcast for each acre, a certain amount was assessed each grower, depending upon his acreage; and supplies for covering a number of thousand acres were secured and the bait prepared according to the second formula given. The prepared material was then broadcast in the same way that seed is broadcast. Several growers spread the material in their fields without removing their herds but we do not believe that this is quite a safe plan to follow.[8]

Before the work was entirely carried out the writer had to leave, and must report further from the observations of Mr. McCall and others. These men reported that the grasshoppers began to die within a day or two, and that within a week they were present only in limited numbers, millions of them being dead in the treated fields.

The two species causing the greater part of the damage were *Camnula pellucida* Scudder and *Melanophus atlantus* Riley. *Anabrus simplex* Hold.

[8] In one field where the bait was put out in piles, several steers were poisoned from eating the bait.

Steiroxys borealis Scudder and *Trimerotropis vinculata* Scudder were also quite plentiful. In Western Oregon our most serious grasshopper pest is *Melanophus femur-rubrum* Harr.

In considering methods of control other than the poison bran mash, discing or plowing in the fall or early spring to destroy the eggs seems to be the most satisfactory. The hopper-dozer has given satisfaction only in isolated cases,

Fig. 27. Grasshopper injury to clover.

and those growers who have tried the poison bait broadcast are strongly favorable to that method and will follow it next season.

Natural Enemies.

We have found two parasites working generally on grasshoppers in this State—a red mite, probably *Trombidium locustarum* Riley; and a fly, *Sarcophoga kellyi* Aldrich. The little red mites may be found on the grasshoppers all through the summer months, and in one case we counted over 100 mites in various stages on the legs, wings, body, etc., of a single grasshopper. These mites undoubtedly cause more or less destruction of the grasshoppers when they are present in such numbers.

The above-mentioned fly is a serious enemy and causes the death of thousands of grasshoppers each season. The adult fly deposits a living larva on the body of the insect, and this larva works into the body of the grasshopper, where it feeds and develops, eventually causing the death of its host.

INSECTICIDE INVESTIGATIONS OF 1914.

(Preliminary).

By H. F. WILSON.

The department of Entomology is carrying on considerable work with insecticides, with a view to securing data on the quantity and kinds of material best suited for Oregon conditions. In order to gain a broader viewpoint of insecticide materials in general, among other experiments, an investigation was started to determine the practical value of every possible material which might serve as an insecticide. The following materials were then selected for trial as poison insecticides and were bought from Eimer & Amend, of New York City:

Ammonium arsenite
Antimony Arsenate
Antimony arsenite
Arsenate of lead
Lead hydrogen arsenate.[9]
Basic lead arsenate.[9]
Arsenate of iron
Arsenite of iron
Arsenite of zinc.[9]
Arsenic bisulphide
Arsenic bromide
Arsenic chloride
Arsenic sulphide (ter)
Barium carbonate
Barium chloride
Barium chromate
Barium sulphate
Barium sulphide
Calcium arsenate
Calcium chromate
Copper acetate
Copper aceto arsenite
Copper arsenate
Copper benzoate
Copper carbonate
Copper chloride—cuprous (Copper Monochloride)
Copper chromate
Copper cyanide
Copper ferrocyanide
Copper sulphide
Copper sulphite
Iron ferrocyanide
Lead chromate
Lead cyanide
Lead sulphate
Mercury arsenate
Mercury arsenite
Mercury bichloride
Mercury sulphide
Mercuric sulphocyanide
Picric acid
Potassium arsenate
Potassium arsenite
Potassium ferrocyanide
Potassium permanganate
Potassium phosphate
Potassium sulphide
Sodium arsenate
Sodium arsenite
Strontium sulphate
Zinc chromate
Zinc cyanide

It was decided to try these out first for possible effect on foliage. Each chemical was used at the rate of ¼ ounce to one gallon of water, and a single tree was used for each. In cases where the wind was blowing, only one side of the tree was sprayed, so as to prevent the spray getting on other trees and interfering with other experiments. The results obtained were classified as follows: Injury severe; Injury serious; Injury slight; Injury none.

Injury severe—Foliage completely destroyed.

Arsenate of soda
Arsenite of soda
Arsenic bromide
Arsenic chloride
Copper acetate
Mercury bichloride
Potassium arsenate
Potassium arsenite

Injury serious—Foliage badly injured but spotted.

Ammonium arsenite
Antimony arsenate
Antimony arsenite
Arsenite of zinc
Copper aceto—arsenite
Copper chloride

Injury slight—Foliage more or less spotted.

Arsenite of iron
Picric acid

[9] The lead hydrogen arsenate and basic lead arsenate were prepared by the Station Chemistry department, and the arsenite of zinc was secured from the J. T. Baker Chemical Co.

Calcium arsenate
Copper benzoate
Mercury arsenate
Potassium ferrocyanide
Potassium permanganate

Injury none, or at least not apparent.

Arsenate of iron
Arsenate of lead (hydrogen)
Arsenate of lead (basic)
Arsenic bisulphide
Arsenic tersulphide
Barium carbonate
Barium chloride
Barium chromate
Barium sulphate
Barium sulphide
Calcium chromate
Copper arsenate
Copper carbonate
Copper chromate
Copper cyanide
Copper ferrocyanide
Copper sulphide
Copper sulphite
Iron ferrocyanide
Lead chromate
Lead cyanide
Lead sulphate
Mercury sulphide
Potassium phosphate
Potassium sulphide
Strontium sulphate
Zinc chromate
Zinc cyanide

All of those chemicals which caused serious or severe foliage injury were then eliminated from further trials. The following chemicals were then tried out to determine their toxic values:

Arsenate of iron
Arsenate of lead (hydrogen)
Arsenate of lead (basic)
Arsenic bisulphide
Arsenic tersulphide
Barium carbonate
Barium chloride
Barium chromate
Barium sulphate
Barium sulphide
Calcium arsenate
Calcium chromate
Copper arsenate
Copper benzoate
Copper carbonate
Copper chromate
Copper cyanide
Copper ferrocyanide
Copper sulphite
Iron ferrocyanide
Lead chromate
Lead cyanide
Lead sulphate
Mercury arsenate
Mercury sulphate
Mercury sulphide
Potassium phosphate
Potassium sulphide
Strontium sulphate
Zinc chromate
Zinc cyanide

From this trial a large number were found either to have no insecticidal value or else to be of no avail as a toxic in practical quantities. The following were found to have desirable toxic values:

Arsenate of iron
Arsenate of lead (hydrogen)
Arsenate of lead (basic)
Arsenic bisulphide
Arsenic tersulphide
Calcium arsenate
Copper arsenate
Mercury arsenate

The mercury arsenate and calcium arsenate injured the foliage so badly, however, that they were eliminated from future consideration.

An experiment was carried out to determine the effect on foliage of a number of chemicals alone and with lime-sulfur, to see if they could be used with absolute safety. The applications were made June 7, 1914.

Table III.

Check, water	No injury.
Basic Lead Arsenate	No injury.
Lead Hydrogen Arsenate	No injury.
Arsenite of Zinc	Foliage injured so that every leaf fell.
Arsenic Bisulphide	No injury.
Copper Aceto-Arsenite	Injury serious.
Arsenic Tersulphide	No injury.
Copper Arsenate	No injury.
Ferrous Arsenate	No injury.
Basic Lead Arsenate + Lime-sulfur (residue) [16]	Apparently no injury, although some scab injury present.

Lead Hydrogen Arsenate+Lime-sulfur (residue)[16]. No injury.
Bordeaux Mixture 4-4-50+Black Leaf-40 1-1000.....Foliage shows no injury. Fruit slightly russetted
Lead Hydrogen Arsenate+Lime-sulfur.....Foliage injured so that every leaf fell.
Basic Lead Arsenate+Lime-sulfur.....Foliage injured so that every leaf fell.
Arsenic Bisulphide+Lime-sulfur.....Foliage injured so that every leaf fell.
Arsenic Tersulphide+Lime-sulfur.....Foliage injured so that every leaf fell.
Arsenite of Zinc+Lime-sulfur.....Foliage injured so that every leaf fell.
Copper Aceto-Arsenite+Lime-sulfur.....Foliage completely destroyed. Fruit blackened and cracked.
Ferrous Arsenate+Lime-sulfur.....Injury not as bad as other, but serious combination. Unsafe.

[16] These materials were prepared for us by the Chemistry department as follows: The lime-sulfur was combined on a basis of 1-30 plus arsenate of lead 2-50. Then the solid matter containing the arsenate of lead was removed, washed and dried. Other chemicals were used at the rate of ¼ ounce to one gallon of water.

These experiments indicate that while certain arsenical sprays may be used without danger of foliage injury, they may not always be safely used in combination with lime-sulfur.

An experiment was conducted to determine the comparative toxic values of chemicals which are known to be toxic and which may prove practical as insecticides. Five gms. of material were added to each pint of water, and larvae of *Malacasoma pluvialis* were used. The materials were applied May 16, 1914.

Table IV. Showing Number of Dead Each Period for Different Sprays.

	May 17, 18		May 19	May 20	May 21	May 22	May 23	May 24	Total
Lead Hydrogen Arsenate	0	176	76	90	22	49	.....	.....	413
Basic Lead Arsenate	0	141	116	213	118	109	.....	.....	697
Arsenite of Zinc	550	550	71	88	29	74	.....	.....	812
Arsenic Bisulphide	127	87	33	80	10	28	.....	.....	365
Arsenic Tersulphide	177	273	160	114	76	.....	.....	.....	800
Copper Arsenate	56	63	41	73	34	17	34	.....	318
Mercury Arsenate	0	101	114	59	25	28	.....	.....	327
Calcium Arsenate	89	132	64	83	23	95	.....	.....	486
Copper Aceto-Arsenate	0	116	36	32	62	.....	.....	.....	246
Arsenite of Zinc+Lime-sulfur 1-30	0	82	40	55	41	.....	.....	.....	218
Lead Hydrogen Arsenate+Lime-sulfur 1-30	0	89	47	93	52	135	.....	.....	416
Basic Lead Arsenate+Lime-sulfur 1-30	0	0	40	81	68	6	33	16	244
Check	0	0	0	8	.....	.....	65	Final total	77

The nature of the insect used is such that the number of larvae being placed on the twigs could not be counted beforehand. Our estimates in some cases were several times too high. We do not believe, however, that the results of the experiments have been impaired. The results obtained indicate that all of these materials in the strengths used were very efficient, with but little real difference between them. Further trials with weaker strengths are necessary.

Summary.

In these experiments a number of chemicals—lead hydrogen arsenate, basic lead arsenate, ferrous arsenate, arsenic bisulphide, arsenic tersulphide, copper arsenate—have given sufficiently satisfactory results as practical insecticides to warrant further experimentation. Both arsenates of lead, when properly prepared and used alone, may be used with safety, so far as injury to fruit and foliage is concerned. Under Northwest conditions, it is more or less unsafe to combine any arsenical spray with lime-sulfur, since spray injury is liable to follow such combinations.

Bordeaux mixture may be combined with Black Leaf-40 without causing foliage injury or loss of efficiency as an insecticide. The solid matters obtained from a combination of arsenate of laed and lime-sulfur do not appear to be responsible for the injury which results from this combination when the liquid and solid parts are applied as one.

Experiments carried on with crude oil emulsion and distillate oil emulsion,

to determine the effect on trees, show that even ten applications in one season tend to improve the health of the sprayed trees rather than otherwise.

Experiments with soluble sulfur show that this material is an effective insecticide against the San Jose scale and some other insects.

Experiments carried on with "Agfa" weevil oil and "Antimot," two preparations put out by the Berlin Analine Works, of New York City, show that these preparations are not efficient fumigants against insect pests.

THE VARIEGATED CUTWORM.

Peridroma margaritosa saucia Hubn.

By A. L. LOVETT.

During the summer of 1914, a serious outbreak of cutworms occurred throughout Western and Northern Oregon. Practically every type of crop was attacked. Truck and garden crops suffered most, but the injury to the buds and fruit of trees and bushes, to field crops, and to ornamental shrubs and plants was serious. The injury became most pronounced in early July. It had reached its zenith by early August and then rapidly subsided. The cutworm causing the greater part of the injury is known as the variegated cut-worm.

Recent History in the Northwest.

The variegated cutworm is by no means a new insect. It is mentioned in Europe as early as 1790; but it has never proved a serious pest there. This cutworm has been a pest throughout the United States for years. Outbreaks of a more or less serious nature occur in some sections practically every year, though usually local in character.

During the season of 1900, a very serious outbreak of the variegated cutworm occurred in the Northwest. British Columbia, Washington, and Oregon were swept with a scourge of these worms. The injury was most serious in Oregon from late June through July to early August. Garden crops suffered most, but there were few cultivated crops that escaped. Prof. F. H. Chittenden[10], estimates the total injury due to this cutworm in 1900 as no less than $2,500,000. Washington possibly bore the brunt of the attack with an estimated loss of $1,012,500.

In 1905 a rather serious outbreak of this cutworm occurred in British Columbia, though comparing in no way with the outbreak of 1900. The variegated cutworm has been present in Oregon every season since 1900. Reports of individual losses during March and again in midsummer are frequent. During the summer of 1913, more than the usual number of these reports of injury were received. The cases appeared as individual losses, however, and were attributed largely to the methods of culture practiced. This summer generation of worms of 1913 undoubtedly found ideal conditions for development and were directly responsible for the great numbers of cutworms in the early season of 1914.

Habits and Life-History.

The variegated cutworm is decidedly cosmopolitan, both in its range and food habits. In the average season, it is probably best known as a greenhouse pest. It is by far the most common cutworm found in greenhouses, and its easy adaptation of feeding habits to conditions surrounding it is readily shown here. Depending on the type of plant attacked, this cutworm will feed underground, at the surface of the soil, or it will climb the stalks of chrysanthemums, etc., and feed on the developing bud at the tip.

Under outdoor conditions this cutworm shows a decided preference for cultivated crops and is normally found in garden and truck fields. It will feed readily on weeds or grass when forced to do so; and in seasons when it is abundant it becomes a pest to every type of crop. It readily becomes a climbing cutworm, feeding on the buds, fruit, and foliage of bushes, vines, and trees. It easily assumes the army-worm habit, moving in hordes and feeding in the day time almost as readily as at night, which is the normal time of activity for most cutworms.

The life-history varies considerably with the locality, and at best the generations are not clearly defined. There are undoubtedly two generations each year in Oregon, and very probably a partial third generation. The winter

[10]Chittenden, F. H., U. S. Dept. Agr. Div. Ent. 1902, Bul. 38, p. 91.

is passed, in Oregon, as half-grown cutworms in the soil. It is very probable that a few pass the winter as pupae, and some may pass the winter as adult moths. Half-grown larvae have been collected in the soil in numbers during

Fig. 28. The Variegated Cutworm (*Peridroma margitosa saucia* Hubn.), working in tomato.

January. Mature larvae are recorded as early as March 6, and during March, 1914, numerous reports of cutworm injury were received. Specimens of mature larvae of the variegated cutworm were received from Valley Falls, Oregon, in early March. They were reported as present in countless numbers in plowed and unplowed, cleared and uncleared land, occurring in greatest numbers about the roots of sage. Strangely enough, the adult moths from these cutworms did not emerge from the breeding cage in our outdoor insectary until September 12.

Adult moths have been collected at Corvallis during April, May and June, and again from August 28 through September. Eggs were plentiful in June and those of the second generation of moths were collected in numbers September 7 to 11. During trips over the infested areas from July 22 to August 5, the insects were found principally as mature worms. Specimens were collected only half-grown, and a few freshly transformed pupae were observed.

Briefly, then, the general life-history is about as follows: The winter is passed in the soil of cultivated fields as half-grown larvae. These worms are active for a time in early spring and do considerable damage to young plants. They mature in late March and April and emerge as adult moths during April, May, and June. The moths deposit eggs and the worms from these eggs form the summer generation, which inflicts such heavy losses during late June, July, and early August. This generation of worms transforms to moths during late August and September. The moths deposit eggs that produce the half-grown worms which are found in the soil during the winter.

Plants Attacked.

To attempt to give a complete list of the food plants of this cutworm in this brief article is impracticable. As has been stated before, almost any plant may be used as food. Truck and garden crops are most subject to attack,

the newly set plants being cut off at the ground. The fruit of tomatoes, the heads of cabbage, and the ears of sweet corn are tunneled into and ruined. Potato tubers and foliage are devoured; hop vines are often completely defoliated; heads of clover are cut off or the side eaten out; strawberry plants are girdled just at the crown; bush fruits are stripped of the fruit and foliage; and fruit trees are often killed outright because the worms, in addition to devouring the foliage and fruit, cut off the developing leaf buds.

Numerous specimens of injured tomatoes (see Fig. 28) were received the past summer. Potato fields were defoliated in various sections. Several hop fields suffered considerably. In a clover field visited in July, the greener heads were found half devoured and not developing normally.

Fig. 29. Work of Variegated Cutworm on apple.

In connection with some observations on an attack on the fruit of apples at Hood River (see Fig. 29), Mr. Leroy Childs, of this department, states that the worms were abundant in the clover which was used as a cover crop in the orchard observed. The apples on the limbs which hung down into this cover crop were most seriously attacked. Following his observations in late July, a codling-moth spray was applied. The cover crop was well drenched with the spray. When he again visited this orchard a few days later not a live cutworm could be found.

Description.

The Moth is one of the larger cutworm moths or Noctuidae. The body of a well-developed moth will measure nearly one inch in length. The wings have an expanse of two inches. The general color of the fore wings is grayish,

Plate II.

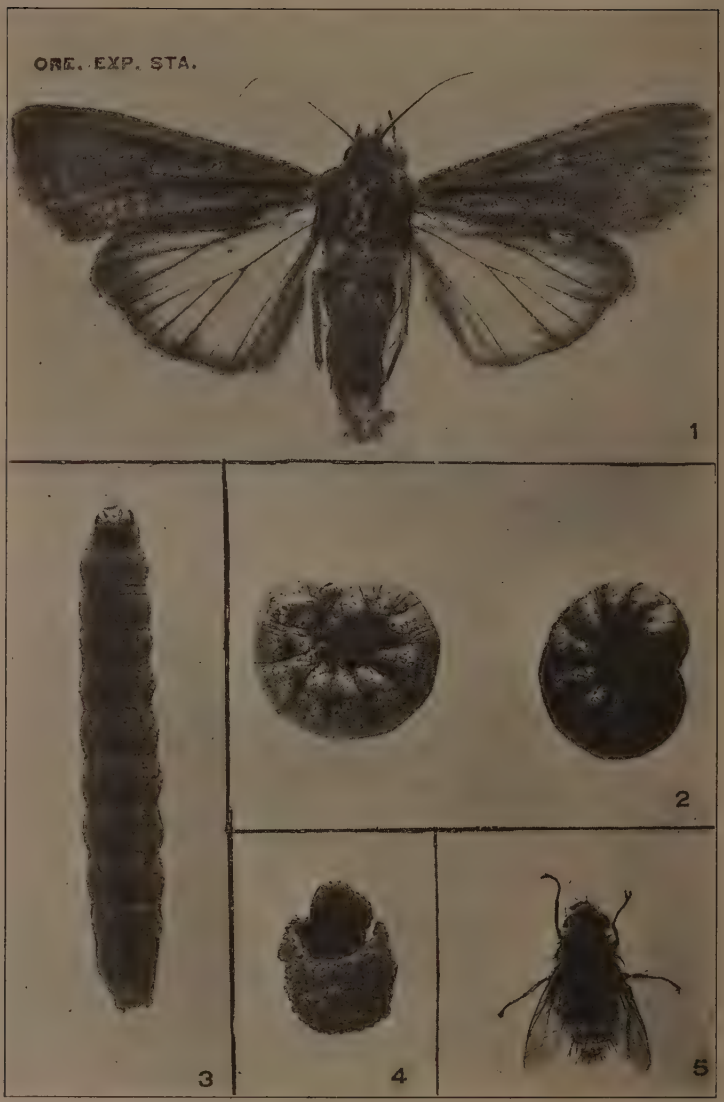


Plate II. The Variegated Cutworm (*Peridroma margaritosa saucia* Hubn.). 1. The adult moth (enlarged 2x). 2 and 3. Larvae. 4. Pupa and part of earthen cell. 5. Tachinid parasite (*Phorocera saundersii* Will.), (enlarged 2.5x).

strongly tinged with red, and shaded about the middle and toward the margin with dark brown. The hind wings are a clear irridescent white, shaded at the margin with soft brown. (See Plate II.)

The Egg is half round in form, strongly ribbed, and small in size. These eggs are deposited in regular masses on twigs and leaves (see Fig. 30).

The Mature Larva is about 1¾ inches in length and ¼ inch wide. It is quite variable in color, from light greenish-gray to dull dark brown. The mottling is fairly uniform and occurs as shown in Plate II. The small elongate, yellowish spots on the mediodorsal surface of segments 2 to 5 are fairly characteristic.

The Pupa occurs in the soil as a deep-shining brown capsule or chrysalis nearly one inch in length.

Fig. 30. Eggs of Variegated Cutworm on leaf.

Natural Enemies.

It is undoubtedly the natural enemies of the variegated cutworm that check it sufficiently in the ordinary season so that a normal crop can be grown. All observations go to show that these natural enemies are only partly successful. Methods of control should be carefully studied and every possible practice followed that seeks to reduce the numbers and injury of this serious pest.

Of the cutworms collected in clover on July 22, 1914, near Halsey, Oregon, nearly 80% were parasitized by Tachinid flies. The majority of the flies were *Phorocera saundersii* Will.; two were *Euphorocera claripennis* Will. Other Tachinid flies have been reported as parasitic on this cutworm; also, several species of Ichneumonidae.

Predaceous beetles, several species of birds, domestic fowls, and pigs are reported as feeding on these worms.

Control Measures.

The cultural methods discussed later and the judicious use of poultry on confined areas should receive attention. When the worms are actually present in the field, however, there is no remedy known which equals the poison bran mash treatment.

Poison Bran Mash. This material, when properly prepared and applied, is preferred by the cutworms to the vegetation. The expense is not prohibitive and the effects are quick and sure. This material, is, therefore, considered the standard treatment for cutworms. It is prepared as follows:

Coarse bran	50 pounds
Paris green or white arsenic	2 pounds
Syrup or brown sugar	1 quart
Salt	1 pound

Warm water to make a coarse, crumbly mash.

The dry ingredients should first be thoroughly mixed together and the water then added. Do not get the mateaial sloppy; have it so it will fall apart readily in the hand after pressing together. A half barrel is a good

receptacle in which to mix the material. White arsenic is just as efficacious as paris green and costs, in small quantities, less than half as much. Fifteen pounds of the mash to the acre is sufficient for the most serious case. This material is simply broadcast over the infested area; the ideal method is to have the mash break into small flakes, a few of which fall near each plant.

In early August of the past summer, following the report of a serious outbreak of this cutworm in the potato district near Clatskanie, Oregon, a demonstration was given at that place, in the preparation and application of this poison bran mash. The field of about 16 acres was very badly infested, at least one-third of the potato plants being absolutely defoliated. The cutworms were present in great numbers and were spreading rapidly. The bran mash was applied at the rate of 15 pounds to the acre over the entire field. The treatment gave absolute satisfaction. The injury was checked and the live cutworms disappeared. For a few days following the application, dead worms could be found, but their spread and work were brought to a halt.

For small home gardens and similar conditions where a smaller amount is sufficient, the following modified formula is given.:

Coarse bran	15 pounds.
Paris green	10 ounces.
Syrup	1 pint.
Salt	5 ounces.

Water to make a coarse, crumbly mash.

Poison Vegetable Bait. Sometimes bran is not very easy to obtain. Another material possibly equally as good is the vegetable bait. Spray a patch of clover, pigweeds, or some useless succulent vegetation, with a solution of one pound of lead arsenate to 25 gallons of water. Mow close to the ground and place in small heaps about the field. This treatment is best applied in the evening. The vegetation thus remains green longer and is therefore more attractive to the worms.

Protective Cylinders made of false bristle board or old tin cans with the top and bottom removed are often used about newly set plants to protect them from cutworm attack. The lower edge should be forced a short distance into the soil for best results. A small heap of the poison bran mash about newly set plants will usually prove an efficient protection.

Trap Lights are often recommended for catching the adult moths at night. There are many accounts of fabulous catches of moths by their use. These trap lights have been given a very thorough test by many entomologists, including the writer. To the uninitiated, to whom all insects are injurious, the trap lights appear of value. After many tests and careful counts, however, taking into consideration the cost and trouble of maintenance, we do not advise trap lights for use against cutworms. The cost and trouble are considerable. As many, or more, beneficial insects are captured as of the injurious forms. The majority of the cutworm moths captured at trap lights are either males or spent females; i. e., those which have already oviposited.

Plowing in the fall or early spring is recommended. For such forms as pass the winter as pupae, this practice is fatal. While the practice in itself may destroy but few of the half-grown larvae, it does remove their food supply. Crop remnants and weeds should, by all means, be removed from the infested field; and this is best accomplished by deep, thorough plowing.

Incidentally, this practice affords an excellent opportunity to use the poison bran mash, and the following practice is the one we should urge as **the very best general practice for the control of the variegated cutworm in Oregon.** Plow as recommended above, taking care to have the land absolutely free of green vegetation. Then in the spring, previous to setting the plants in the ground, or a few days after the seeds are planted, broadcast the poison bran mash over the fallow ground. The worms, being hungry, will feed greedily on the poison and will be killed before the crop is present for them to injure.

Caution. Chickens should not have free access to a field treated with the bran mash.

Summer Surface Cultivation. Frequent shallow surface cultivation

throughout the growing season of the plants will encourage plant growth and destroy untold numbers of cutworms which happen to be in their transformation stages in the soil.

Climbing Cutworms may usually be checked by the use of the poison bran mash about the base of the tree. Caution should be used to have the mash crumbly. A sloppy mash in contact with the tree or plant will cause serious injury. Bands of sticky materials, several commercial types of which are on the market, are of fair value; likewise the various cones and cylinders which are advertised. Jarring the trees in the evening about 10 p. m. will often dislodge worms. They can be caught in a large canvas or sheet and destroyed. This practice should be repeated every night until the poison has had an opportunity to act.

In the Greenhouse hand picking and the use of the poison bran mash are usually effective. The hand picking should be done at night by the aid of a lantern. Practice will give one efficiency.

Summary.

The variegated cutworm is one of our most common and injurious forms of cutworms. Every year it is present and doing considerable damage. Natural enemies will do much to prevent a recurrence of the pest in countless numbers, but must not be relied upon entirely. By persistently fighting this pest from year to year, we can prevent serious outbreaks and reduce the annual loss. The poison bran mash, broadcast over the soil in the spring before the crop is up, will destroy most of the cutworms.

THE OLIVE GREEN CUTWORM.

Dargida procinctus Grote.[11]

Specimens of a dark olive green cutworm were received from Mr. Wm. M. Black, of Marshfield, Oregon, on July 24, 1914, with the report that they occurred in great numbers in the meadow lands and as a result of their work, the grass was all dying, even the roots seemingly having no life. These worms were placed in a breeding cage, from which the adult moth emerged August 28. They proved to be *Dargida procinctus*, a western species of moth not previously referred to as a pest in economic literature.

Nature of the Pest.

This cutworm has not been observed feeding on other food plants than grass. As greater areas are devoted to cultivated crops, and the amount of their natural food plant is in consequence cut down, the worms may later become a pest of cultivated crops. The very limited observations made on the larvae show them to be gregarious in habit, with tendencies toward the army-worm type. In 1912, specimens of larvae of what is believed to be this species were received from Hood River, with the report that they were traveling in hordes across a cleared area. Unfortunately all but two of the specimens had died in transit, and both of these were placed in a breeding cage to rear adults. They pupated almost immediately, but failed to emerge.

Distribution.

Dyar[12] gives the range as California and Oregon.

Holland[13] gives the range from Colorado to California and Oregon.

Life-History.

This species undoubtedly passes the winter as larvae. Mature larvae have been collected in March and April. Some may pass the winter as pupae. Adult moths have been collected at Corvallis in May, June, August, September, and

[11]Grote, Bul. Buff. Soc. 1873, I, 138.
[12]Dyar, H. G., N. A. Lepidoptera, U. S. N. M., 1902, Bul. 52, p. 157.°
[13]Holland, W. J., The Moth Book, 1903, p. 196.

Plate III.

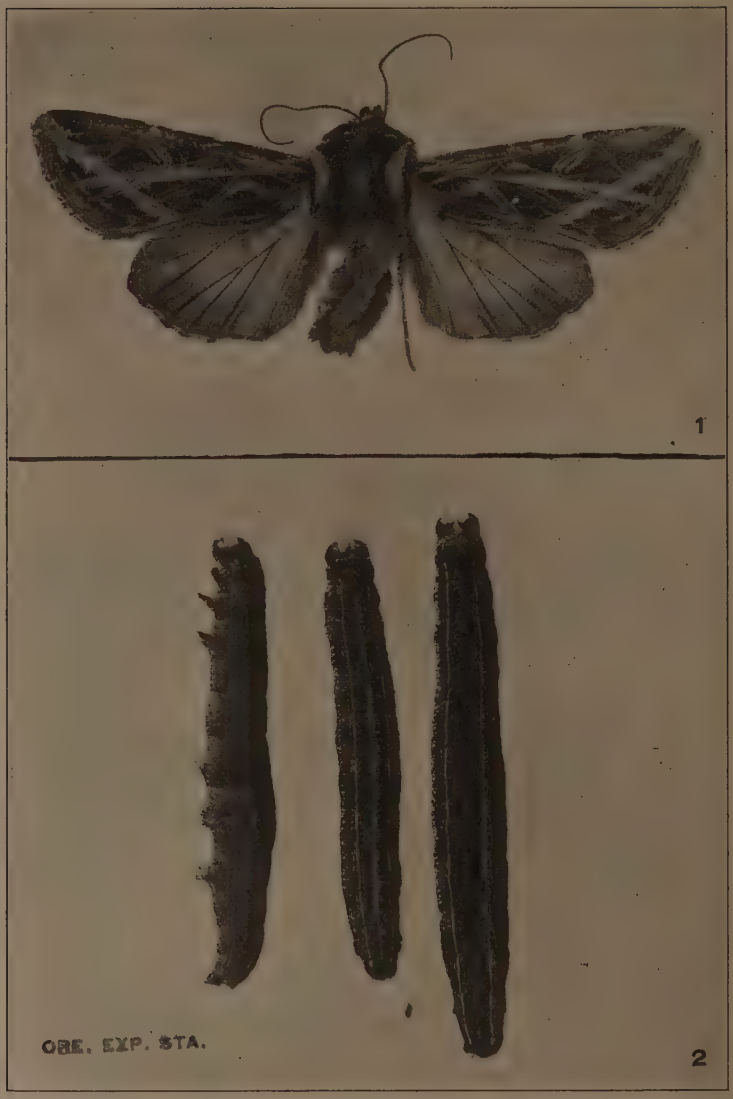


Plate III. The Olive Green Cutworm (*Dargida procinctus* Grote). 1. Adult moth. 2. Larvae (enlarged 2x).

November. Therefore, it is possible that a portion pass the winter as adult moths. There are undoubtedly at least two generations during the year, and possibly an incomplete third generation, or else the generations overlap and are not clearly defined.

Description.

The Larva. The mature larva measures from 1 1/8 to 1 1/4 inches in length. is 3/16 inch across and nearly as high. The general color is dark olive green, The dorsal surface is of this shade with an inconspicuous median line of gray. The sides have three greenish-gray lines separated by two light brownish-gray lines. Ventral surface blue-green to greenish-gray. Head on vertex dark olive green, shading off on cheeks to greenish-gray. Whole color scheme faintly mottled. Head sparsely haired, hairs more numerous and longer on face just above mouth parts. Antennae located on a large triangular prominence, two-jointed with a long terminal arista. Simple eyes seven on a side, five on cheek forming crescent, one just below antenna, one above.

The Pupa. The pupa is 3/4 inch long and light red in color.

The Adult. The body of the adult is 3/4 inch long, and the wing expanse 1 3-4 inches. General color dark brown with olive tints. A very distinctive color pattern in light creamy brown (see Plate III).

Control Measures.

Same as for variegated cutworm. See page —

THE ROSE CURCULIO INJURES BLACKBERRY BUDS.

Rhynchites bicolor Fab.

By A. L. LOVETT.

The rose curculio has long been recognized as a serious pest of roses. The total damage to roses which this curculio causes annually in Oregon is hard to estimate. Recent observations would indicate that it may become a serious pest of cane fruits.

On May 27, 1912, near Russellville, Oregon, the flower buds of the blackberry were found severely injured, due to the feeding and egg punctures of the rose curculio. The punctured buds were brown in color and dead. The stem for a short distance below the bud was also dead, and the bud drooped over. In many cases, the entire flower-bud cluster was blighted. But few clusters had escaped entirely. The number of punctures in the blighted buds varied in number from one to nine.

In nearly every case there was a single egg inside. An occasional punctured bud was found with no egg inside, and in a few cases two eggs were found in a single bud. Due to the dried condition of the buds, it was impossible to distinguish between the egg punctures and the feeding punctures. It is assumed that normally but a single egg is deposited in each bud by an individual. In those occasional cases where more than one egg is found, the bud was probably visited by a second female curculio.

The adult curculios were fairly plentiful about the field. Nearly every flower bud cluster had one or more beetles, and sometimes there were several present. The beetles were very sluggish and dropped readily when disturbed. Loganberries and raspberries were growing in adjacent plots, but showed no indication of attack.

In 1913 and 1914 the injury was reported to be as serious as in the preceding year, or slightly more so, the total injury affecting from one-half to two-thirds of the buds.

Food Plants of the Curculio.

LeConte[14] as early as 1876 refers to this curculio as "an abundant species found on wild roses from the Atlantic to the Pacific Coast." James Cassidy[15] in 1888 speaks of it as feeding upon wild and tame roses and on raspberries in large numbers. It is reported in California[16] in 1894 as puncturing the ripe fruit of blackberries and raspberries, causing it to decay. In 1909[18] it is reported as feeding on the rugosa or Japanese rose. In addition to the buds and flowers, the curculio attacks the clusters of tender unfolding leaves. R. A. Cooley[19] mentions the work of the larvae in the rose-seed pods.

Nature of Injury.

Roses probably suffer more from the attack of this curculio than anything else. The unfolding flower buds, the flowers, leaf clusters, seed pods, and even the tender stems are punctured by the beak of the adult beetle. Often an unfolding bud which has been punctured will continue to open and the full-blown rose will have the appearance of the wild rose in Fig. 31. The larvae feed in the seed pods, devouring the seeds and leaving little but the shell. In many cases where the adult beetle punctures the flower bud, she will also puncture the stem below, causing the stem and bud above the puncture to droop and die. Where the tender, growing stems are punctured, the tips turn black and die.

[14]LeConte and Horn, 1876.
[15]Cassidy, James, 1888.
[16]Craw, Alexander, 1893-4.
[18]Gates, B. N., 1909.
[19]Cooley, R. A., 1903.

Plate IV.

Plate IV. The Rose Curculio (*Rhynchites bicolor* Fab.). 1. Flower bud cluster of blackberry showing punctures. 2 and 3. Flower buds of blackberry showing curculio eggs in situ. 4. Adult curculio. 5. Larva. Adult and larva enlarged 2x.)

Control Measures.

No really satisfactory control measures are known. Advantage may be taken of the curculio's tendency to drop when disturbed, and the beetles may be jarred from the plant into some container and destroyed. This practice is of

Fig. 31. Wild rose showing the work of the Rose Curculio.

value only under certain conditions. At best it should be supplemented by the eradication of wild rose bushes in the vicinity, where practical; by hand picking and destruction of punctured seed pods; and by the use of sprays.

A spray of one pound of lead arsenate to 20 gallons of water should be used as soon as the beetles appear in May. As the blossoms of the rose advance, or the berries of the cane fruits become of some size, the use of an arsenate should be discontinued. The arsenical spray discolors the foliage and flowers of the rose, and it may also injure the berries of the cane fruits.

After this time, use a spray consisting of one ounce of white hellebore powder to three gallons of water. This spray is practically colorless and is non-poisonous to human beings. Insist on having fresh, pure hellebore.

Our observations indicate that the insect passes the winter as a pupa in the soil. If this is true, a thorough stirring of the soil about the plants during late September and October, and also in the early spring, should be of value in destroying these over-wintering pupae.

Description.

The Adult is one of the Rhyncophora or so-called snout beetles. The wing covers and thorax are red. The head, snout, and legs are black. Exclusive of the snout, the beetle measures from $^3/_{16}$ to $^1/_4$ inch in length. The snout is long and bears a pair of clubbed antennae near the middle (see Plate IV, Fig. 4).

The Larva is a white footless grub. The head is small and light brown in color. Length when full grown, $^5/_{16}$ inch. It rests in a curled position.

The Egg is elongate oval, saffron-white in color. It measures .9 mm. to 1.2 mm. in length and .65 mm. to .82 mm. in diameter.

Approximate Life-History.

While several attempts have been made to work out the life-history of the rose curculio in our breeding cages, the work so far has been unsuccessful. Adult beetles are present and active from late spring until late summer and early fall. Eggs have been found from May until late July. All evidence goes to show that but a small per cent of the eggs ever hatch. Of the eggs collected in the blackberry flower buds, less than 6% hatched, and the young grubs did not feed at all in the dead buds. The egg stage is about 20 days.

Rose-seed pods were found in late August and September containing from the very small to the full-grown grubs. Other seed pods were found at this time with all the inner portions devoured, leaving only the hard outer shell, from which the larvae had disappeared. All efforts to obtain pupae were without success.

It is believed that for Oregon conditions, the insect is single brooded; that the adults emerge from over-wintering pupae in the soil. These beetles are present in the field and practice oviposition until early fall. The very small per cent of larvae which emerge successfully from the earlier-deposited eggs develop very slowly; the later-emerging larvae develop more rapidly and all transform during late summer and fall to pupae in the soil, and so pass the winter.

Summary.

The rose curculio is a very serious pest of roses in Oregon. It has been doing serious injury to the flower buds of blackberries during the past three seasons in a field near Russellville, Oregon.

While raspberries and loganberries in adjacent plots showed no evidence of injury, this is no positive evidence that these plants will not eventually be included as food plants. The raspberry was mentioned by James Cassidy as being attacked in Colorado.

Such control measures as can be applied should be vigorously followed up.

Bibliography.

This bibliography is not necessarily complete. It represents the papers referred to in the preparation of this article.

1888. Cassidy, James. Colo. Agr. Exp. Sta. Bul. 6, p. 18.
1901. Chittenden, F. H., U. S. Dept. Agr. Div. Ent. Bul. 27 (N. S.) p. 98.
1902. Cooley, R. A., Mont. Agr. Exp. Sta. Bul. 32, p. 49.
1903. Cooley, R. A., Mont. Agr. Exp. Sta. Bul. 46.
1893-4. *Craw, Alexander, Rept. Cal. State Bd. Hort. p. 86.
1910 Dickerson, E. L. Jour. Econ. Ent. III, 3, p. 316.
1775. Fabricious, T. C., Syst. Ent. p. 131, No. 18, Curculio bicolor.
1787. Fabricious, T. C., Mont. Ins. Tom. I, No. 32, p. 99, C. bicolor.
1792. Fabricious, T. C., Ent. Syst. Tom. I, No. 18, p. 388, Attelabus bicolor.
1909. Gates, B. N., Jour. Econ. Ent. II, 6, p. 465.
1789-06. *Herbst, J. F. W., Kafer VII, Nat. Ins.
1876. LeConte and Horn, Proc. Amer. Phil. Soc. XV, 96, p. 7.
1899. Lugger, Otto, Fifth Ann. Rept. Ent. Minn. p. 180.
1893. Webster, F. M., Ohio Agr. Exp. Sta. Bul. 45, p. 204.

*These two papers were not seen, but references to them were found.

THE RADISH WEEVIL, A NEW PEST.

Cleonus sparsus Lec.[20]

BY A. L. LOVETT.

While investigating a radish field, in connection with some experiments on the radish maggot, *Phorbia brassicae*, the egg of some beetle was observed glued to the side of an occasional radish. Specimens of radishes with the eggs attached were placed in breeding cages for study. When the adults were eventually reared, they were found to be one of the snout beetles, known scientifically as *Cleonus sparsus* Lec.

Nature of Injury.

No observations were made on the food habits of the adult beetles. From a study of closely allied forms, it would seem probable that they feed normally on the foliage of some native plant. It is quite possible that they also feed on the foliage of the radish and turnip.

The larvae tunnel about inside the radish, devouring the whole interior of a small plant. When mature they come to the exterior and work out a longitudinal groove on the side of the radish. This groove is then covered over with particles of earth glued together. This work renders the infested radish unsalable and unfit for food.

Food Plants.

Radishes and turnips have been found infested by the grubs. The pressure of other duties prevented a thorough survey for additional food plants of the larva or for those of the adult beetle. It was likewise impossible to determine the distribution or the extent of the infestation over the State.

Notes on Life-History and Habits.

A pair of the adult beetles in copulation were collected by Prof. H. F. Wilson on a cement walk at Corvallis, Oregon, April 15, 1911.

No observations were made this year previous to finding the eggs on the radish July 7. Eggs were plentiful at this time. A single newly-emerged grub was collected. A few of these eggs, collected July 7, hatched July 10. The majority hatched July 13 to 16. The eggs are deposited directly on the skin of the root plant. An abundance of sticky exudation must accompany the egg when deposited, for they are completely covered and encrusted by a thin wall of soil particles. There is a slight pitting of the surface skin beneath the egg, due probably to the growth of the root. The skin under this encrustation remains tender, affording the grub ready entrance.

The young grub emerges from the egg at the point where it comes in contact with the surface of the root, and burrows directly into the interior. When mature, it comes out and forms a longitudinal groove on the side of the root plant. Particles of earth are glued together outside this groove, forming with the groove a neat little cell. In this cell the larva pupates and transforms to the adult beetle (see Plate V).

The first pupa occurred July 24. The first adult was observed August 4. Mature larvae and pupae were found in the field as late as August 28. The grubs observed at this time were in the cells on the side of the root. The majority of the beetles in the field at this time (November 18) are in these pupal cells on the side of the radish in the soil. It is reasonable to suppose that they will remain here inactive until early spring. An occasional empty cell indicates that a few beetles emerge in the fall. This agrees very well with the habits of *Cleonus punctiventris*, which is a very serious pest of sugar beets in Russia. The adult of this species is reported as remaining in the soil until early spring.

[20]Leconte, L. J., and Horn, G. H., Rhync. Amer Proc. Phil. Soc., 1876, XV, 96, p. 152.

Plate V.

Plate V. The Radish Weevil (*Cleonus sparsus* Lec.). 1. Adult weevil. 2. Larva. 3. Pupa. 4. Radish showing pupal cell on side. 5. Radish showing egg, enclosed in soil crust, on side. 6. Radish showing egg with soil removed. 7. Radish showing adult weevil resting in pupal cell on side of root.

Control Measures.

No control measures have been attempted as yet. When the food habits of the adult beetle are known, it is possible that a poison spray may be applied to the foliage on which it feeds.

Recommendations[21] for the control of *C. punctiventris* include rotation; the use of ditches with vertical sides about the field to trap the adult beetles; the use of barium chloride (2% solution) and arsenical sprays; and the use of various fungous diseases for the grubs in the soil.

Description.

The Egg. Dirty, safron-white in color, with slightly glistening reflection. Smooth, without pits or ridges; very slightly oblong, oval. Diameter .9 by .88 mm.

The Larva. First instar 1.6 mm. long; width across prothorax .5 mm. White, head straw color; body grub-like. Mature larva grub-like, 9.2 mm. long, 3.7 mm. wide, 3.1 mm. high. Head small, 1.6 mm. wide, 1.4 mm. long; rather retracted into prothorax. Color white; head light brown, darker near jaws which are dark brown. Body composed of 12 segments, fairly uniform dorsally. Ventrally the meso- and metathorax with fleshy fold and a pair of rounded fleshy tubercles on the ventro-lateral margin. These appear, from a lateral aspect, like prolegs. Segments 4 to 11 with rounded protruding fleshy tubercles arranged in pairs on lateral surface forming double longitudinal row. Larva sparsely covered with fine light brown hairs.

The Pupa. White, 9 to 9.8 mm. long; 4 mm. wide. Snout, wings and legs appressed to ventral surface. Antennae extend back to base of wings. Prothorax shield-like dorsally. Abdomen composed of eight segments. On the posterior margin of the dorsal surface of segments 3 to 7 are transverse rows of eight short, heavy chitinized spines. On the lateral margins of segments 2 to 7 are short, blunt tubercles; on segments 2 and 3 these tubercles bear bristles; on succeeding segments, spines. Near the middle of the dorsal surface of the anal segment is a transverse row of six spines. The segment terminates in a fairly conspicuous pair of fleshy spined tubercles.

The Adult appears superficially of a deep bluish-gray color. The wing cover has a narrow margin above black, then a broad bluish-gray stripe, another black stripe and the lower margin is bluish-gray. The beetle might be termed black with two broad bluish-gray, pubescent stripes on each wing cover. The head is produced into a fairly long stout snout. On the snout the hairs are very short and thick and of a rusty red color. The wing covers have longitudinal rows of punctures. The beetles vary in length from ¼ to ⅜ inch and in width from 1/12 to ⅛ inch.

Other Species of Cleonus.

Chittenden[22] mentions *C. quadrilineatus* as breeding on *Arogallus lamberti* in Colorado.

Gillette[23] tells of injury to the buds and foliage of young peach trees by adult beetles of *C. canescens.*

Ely[24] gives an interesting account of *C. calandroides*, attacking the roots of *Cakili endetula* in Maryland. The habits and manner of constructing pupal cells are very similar to *C. sparsus.*

[21]Danysz, J. et Wize, K, Entomophytes du Charancon des Betteraves a Sucre (Cleonus punctiventris). Ann. D. L'Inst. Pasteur, 1903, XVII, p. 421-446.

[22]Chittenden, F. H., Insects injurious to the loco weeds, U. S. Dept Agr. Bur. Ent. Bul. 64, Pt. V, 1908, p. 37.

[23]Gillette, C. P., **Cleonus canescenes** Lec. as a fruit pest, Jour. Econ. Ent., 1912, Vol. V, No. 4, p. 367.

[24]Ely, Chas. R., Proc. Ent. Soc. Wash., 1913, XV, 3, p. 104.

CLOVER SEED INJURED BY MIDGE.

Dasyneura leguminicola Lint.

By A. L. LOVETT.

The yield of red clover seed in Oregon was decidedly below normal the past season. In a great many cases this was attributed entirely to the work of the clover-seed midge. The midge was present and doing considerable injury in a great many fields this season. However, it was by no means wholly responsible for the light seed crop.

We visited one large clover section south of Albany, Oregon, where the seed crop was so light that it was hardly worth harvesting. A thorough search failed to reveal the presence of a single specimen of the midge. The following conditions were observed, however, and they undoubtedly are largely responsible for the condition of the seed crop. In just how far these same conditions were a factor in the fields where the midge was present is difficult to say.

1. A prolonged drought had rendered the surface soil very hard and compact. There was very little moisture even some distance down.

2. The clover root-borer, *Hylastinus obscurus*, was present, and the majority of the tap roots were tunneled out and injured by this pest.

3. Cutworms were present in great numbers. A small heap of debris in a slight depression would cover from thirty to sixty cutworms. They were cutting some of the heads and eating out the sides of others.

4. Grasshoppers were also present and there were small areas where every stem was girdled near the crown by the hoppers.

5. While portions of the field were in full blossom not a single bee was observed. The owner reported that while in previous seasons the hum of the bees made a loud insistent drone during the blossoming period, he had not seen half a dozen bees in the field all this season.

Fig. 32. Larvae of the Clover Seed Midge (enlarged 10x).

From about Lebanon, Oregon, specimens of immature clover heads were received which were simply alive with the little salmon-pink maggots of this midge. This field had been pastured in the early season, and clipped off in early May. In spite of this practice, which is usually a sufficient protection against the midge, we have here a serious infestation.

Because of the injury both real and assumed, from the midge, a circular letter dealing with the clover seed pests was prepared. A copy follows:

Two Clover Seed Pests.

By A. L. LOVETT.

There are two insects present in Oregon which may seriously affect the production of red clover seed. These pests are known as the clover seed midge and the clover seed chalcid. The former attacks the unfertilized seed ovule; the latter breeds in the maturing seed.

The Clover Seed Midge (*Dasyneura leguminicola*) is the most serious pest of red clover seed in the Willamette Valley. Where this pest is present in abundance in a field, the clover heads do not bloom normally. The heads turn brown prematurely and appear blighted, and upon opening the seed capsules, small salmon pink maggots are exposed. These are the maggots of the clover seed midge.

The adult midge is a minute, fragile two-winged fly. These midges appear in the field at about the normal period of blooming of the clover. The females deposit eggs among the opening florets. The young maggots work their way into the open end of the floret, and down to the unfertilized seed ovule. The maggots feed here until mature, when they drop to the ground. Here they spin minute silken cocoons inside of which they transform to adult midges.

The second generation of midges is usually present about the time the second or seed crop of clover begins to bloom. The infestation of the clover heads takes place here in the same way as

above. The full grown maggots work a little below ground to spin their cocoon, and it is in this cocoon in the soil that they pass the winter.

Where the clover field does not bloom normally, if the heads are reduced in size, distorted or lose quickly their pinkish color, one should make a careful examination for the maggots in the seed ovule. The degree of infestation can be approximately estimated, in fact, by the appearance of the field in bloom.

The Clover Seed Chalcid (*Bruchophagus funebris* Haw.) attacks the seed of both clover and alfalfa, and the more serious injury due to it so far, in Oregon, appears to be on alfalfa in the eastern part of the state. Its attack is on the maturing seed and often the first evidence of the injury is observed at threshing time. The infested seeds are light in weight, dull in color and sometimes shriveled.

The adult chalcid is a minute black, wasp-like insect of compact form. These chalcids appear at about the time the clover heads are maturing and the females deposit eggs inside the shell of the seed. They choose the seeds where the shell is not yet completely hardened. The grubs feed on the interior of the seed. They may abandon one seed, eat into and devour another. They transform inside the mature seed, and the adult chalcid eats its way out. As in the case of the midge, there are two generations of chalcids; one for each crop of clover heads. Those of the second generation pass the winter in the stored seed, emerging in the spring.

Control Measures. So far as is known, the same control measures will apply to each of these pests. In a normal season, these pests are present in their greatest abundance at the time the clover normally blooms. To change slightly by some practice the normal time of blooming of the clover seed crop affords our most feasible method for lessening their injury.

If it is desired to obtain both a hay and a seed crop, the hay crop should be mown a little earlier than the ordinary time. Any immature forms of the pest in the heads will die out in the cured heads and the time of the seed crop will be advanced sufficiently to miss the main brood of the second generation. Another practice is to pasture for a time in the spring (May 10-18), then clip the field and grow only a seed crop. Any practice that suggests itself, which has for its object the altering slightly of the time when the seed crop of clover blooms, should give the same results.

All volunteer clover and alfalfa along the fence rows and irrigation ditches should receive attention. Where neglected, these afford an ideal breeding ground for these seed pests.

Caution. In examining the clover head for the maggot of the clover seed midge, do not mistake the little scarlet red thrips for the maggot. There is a thrips often found in the clover head, which as a nymph is long and slender, a scarlet red in color, and moves with a gliding motion. The maggot of the clover seed midge is a salmon-pink in color, of the true maggot form (see Fig. 32), and it is found normally inside the individual seed ovule.

NEMATODE GALLWORMS OR EELWORMS.

Heterodera radicicola Mull.

By A. L. LOVETT.

Considerable interest is manifest concerning the eelworms or nematode gallworms, due largely to the recent agitation concerning their injury to potatoes. Because of the presence of these worms in neighboring states, it seems advisable to warn our growers of the possibilities of the pest, and to urge them to use every precaution to prevent its introduction into their fields.

What Nematodes Are.

The nematodes or nematode worms are not insects. They belong to the round worms or Vermes, and are much lower in the animal scale than are insects. Popular names for nematodes include "threadworms," "eelworms," "flukes," etc. Most forms are of no economic importance, living principally on decayed matter. A number of forms are parasitic for at least a portion of their life on animals, and a few forms are parasitic on plants.

Host Plants.

The list of plants known to be attacked by this nematode includes over 450 names. Practically all garden and truck crops are included as hosts; many of the field crops and a great variety of fruit, shade and ornamental trees, shrubs, and plants are also attacked. Mr. Schofield[25] mentions the following list of plants as readily and seriously attacked: Beets, carrots, celery, cucumbers, eggplant, lettuce, muskmelons, watermelon, clover, cowpeas, rape, soy beans, catalpa, cherry, elm, and peach.

Distribution.

The nematode gallworm is fairly well distributed over most of the known world. Bessey[26] writes that

> "It has been present in the United States for many years, and has caused losses whose extent cannot be calculated. Although more abundant in the South, it is present, at least sporadically, in all but the most northern and northwestern states, as an out-of-door pest, and is everywhere distributed in greenhouses."

The irrigated potato districts of Nevada are a concrete example of a locality which may regard the pest as a real menace. The pest is present in practically all the region east of the Mississippi River. It is present in parts of California and in scattered sections of the Middle West.

Means of Distribution.

The nematode gallworm may be distributed to new localities in the soil from infested fields, or on the roots of any one of the many plants which it infests.

Nursery stock is one of the most common means of distribution. All shipments of trees, shrubs, plants, etc., of whatsoever nature, should be examined carefully for galls, knots, or irregular growths on the roots. Any such unnatural growth should be viewed with suspicion, and every precaution taken to prevent unwittingly introducing into the soil a pest capable of untold injury.

Potatoes afford another ready means of distribution. Seed potatoes in particular should receive the most rigid examination. Under no circumstances should they be purchased from a locality known to be infested with the eelworm disease.

Symptoms and Nature of Injury.

In the Field. Nematode gallworms, *Heterodera radicicola*, attack the plant under ground, causing a trouble known as root knot, root gall, big root, etc. These irregular enlargements occur at all points on the main and lateral

[25]Schofield, C. S., U. S. Dept. Agr. Bur. Plant Ind., 1912, Cir. 91.
[26]Bessey, E. A., U. S. Dept. Agr. Bur. Plant Ind., 1911, Bul. 217, p. 7.

roots, and are an integral part of the root itself. The gall is made up of abnormal cells which do not function normally. An affected plant, therefore, is

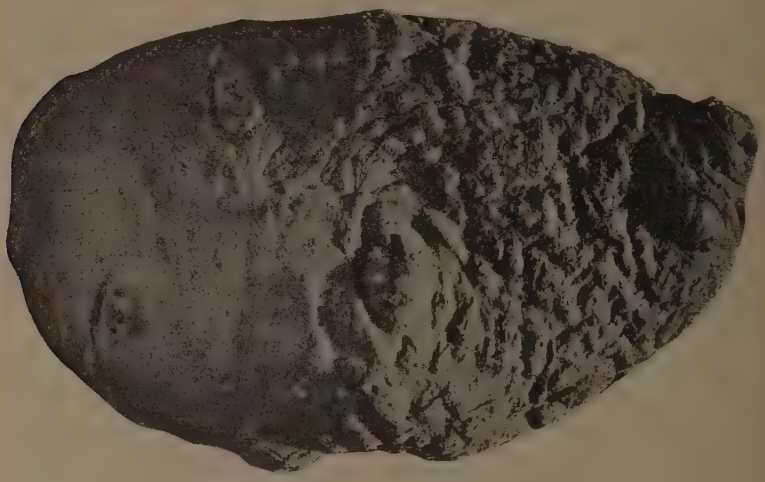


Fig. 33. Potato showing characteristic pimples caused by Nematodes. (After Doten.)

robbed of its normal food supply. The effect of this condition becomes apparent in the lighter crop or in the death of the plant.

The earlier symptoms of nematode injury, apparent above ground, are just as applicable to those of injury by insects or fungi. Where the cause is unknown, however, and these symptoms occur, nematodes may reasonably be considered as a possible cause. An examination of the roots for galls is then advisable. In the earlier symptoms of the disease, a dwarfing of the plant is usually apparent. The plant wilts in the heat of the day, and appears slightly off in color.

On Potatoes. The eelworm of potatoes is a very serious trouble. The most notable example of what the pest can do is found in some of the irrigated potato districts of Nevada. Previous to the introduction of the nematode gallworm, potatoes were one of their most profitable crops. The potatoes produced here were of a superior quality, and usually commanded a higher price on the market than those from other sections. California afforded the principal market for these potatoes. When the presence of the eelworm disease was noted, California quarantined against the potatoes from this section of Nevada, and turned back several cars containing infested tubers.

The skin of the infested potato is usually roughened and cracked, and has irregular pimples over the surface (see Fig. 33). These pimples or nodules are grayish or brownish in color. They are often more or less depressed in the center and surrounded by a slight furrow. In the earlier stages of the disease, the potato may be full and firm, but as the disease advances, the tuber shrivels and becomes more or less soft. Badly diseased potatoes shrivel to one-half the natural size, are soft, lack nutrition, and are unfit for human food.

Occasionally an infested potato shows no symptoms on the surface. Upon cutting into the potato, rings of darkened tissue appear just below the skin, extending from $\frac{1}{16}$ to $\frac{1}{4}$ inch into the flesh. These brownish rings are corky in texture, with a central whitish core. This core contains the nematode gallworms in all stages of development.

In the Greenhouse. As stated previously, the nematode gallworm is distributed practically everywhere in greenhouses. A serious attack of nematodes occurred in a frame of tomato plants in the College greenhouse the past

spring. Unfortunately the pressure of other matters prevented our giving the matter the attention necessary and no determination was made of the species. It is assumed, however, that it is this species.

Fig. 34. Nematode work on tomato; a root showing galls; b, leaf showing characteristic spotting, normal leaf at right.

The symptoms of attack are more apparent above ground in the case of greenhouse plants than with outdoor plants. There is usually more or less forcing of the plants here, and any checking of the thrift of the plant quickly becomes apparent. The first symptoms of injury above ground are a checking in the growth; the plants become a lighter green in color, and are in poor thrift. Later, in the case of tomato plants, deadened areas appear between the ribs of the leaf adjacent to the midrib (see Fig. 34B). The leaves curl, thicken up, and become twisted and off color. The plant eventually wilts down and dies.

The roots are attacked in the same manner as under field conditions. An infested plant will show the abnormal galls and knots.

Control Measures.

In the Field. A great number of materials are suggested as of some value against the nematode gallworms in the field. At best the control methods to be employed here entail considerable time and expense and are only in a measure satisfactory. Keeping the soil free of vegetation for a period of two years, and planting non-susceptible crops are two methods which seem most likely to free the soil of the pest. Either of these methods is expensive. This serves to emphasize the necessity of keeping the pest out of our soil if at all possible.

In the Greenhouse. During late April, Professor Bouquet, of the Horticultural division, reported serious nematode injury to his tomato plants in the greenhouse. The plants were of a very fair size, there being already a considerable setting of fruit. The infested plants occupied the west half of one section of the greenhouse. There were forty-eight plants, twelve in each of four rows. The plants were trained to a single runner, and this was supported upright by a strong twine attached to the roof. At the time when our attention

was called to the trouble, many of the plants were already drooping badly and a few of them were dead.

On April 25, 1914, I treated the frame of tomatoes as follows: The south half of the frame was treated with ammonia water[27], 1% (?) solution. The north half of the frame was treated with formaldehyde, 1% (?) solution. The 1% solution in each case is figured on the basis of 100% for the commercial material. We obtained the commercial 40% formaldehyde and diluted one part of formaldehyde to 99 parts of water. The concentrated ammonia was diluted in the same way, one part to 99 parts of water. This was arrived at only approximately, however, as I used four ounces of the solution to three gallons of water, or 4 to 384.

Fig. 35. Frame in greenhouse showing condition of plants at close of experiment.

One gallon of the solution was applied to each plant. In the checks, one gallon of water was used. A shallow circular trench was formed about each plant; the solution poured into this trench and allowed to soak into the roots.

Table V. Plat of Tomato Bed Showing Treatment.

Row	A	B	C	D	E	F	G	H	I	J	K	L
1	o	x	x	x	x	x	+	+	+	+	+	+
2	x	x	x	x	x	x	+	+	c	o	o	c
3	x	x	x	x	x	x	+	+	+	+	+	+
4	c	x	x	x	c	x	+	+	+	+	+	+

x—Treated with ammonia water.
+ Treated with formaldehyde water.
c Treated with water, check.
o Plant dead.

The plants used as checks were chosen as representative of the lot. Notes were taken at the time of treatment and at various times afterward. These notes are tabulated below:

[27]This idea was gleaned from an abstract of a report by some German investigator.

Table VI.
Effect of Formaldehyde and Ammonia Water in Nematode Attacks.

Row and plant	April 25	April 28	May 8	May 12
Row 1A	Dead			
Row 1B	Off color, not doing well	Worse, leaves curling	Decidedly improved, good color	O. K.
Row 1C	Top good, some spotting lower leaves	About same	Color good, growing well	O. K.
Row 1D	Wilted, leaves badly spotted	Dead		
Row 1E	Slightly off color, not thrifty	No change	Much improved, growing nicely	O. K.
Row 1F	Top good, lower leaves light green	No change	Doing well	O. K.
Row 1G	Small, color very good	No change	Dead	
Row 1H	Color good, slight leaf spotting	Badly wilted, no apparent cause	Dead	
Row 1I	Growth good, slightly off color	No change	Dead	
Row 1J	Color and growth, average	No change	Dead	
Row 1K	Small, color fair	No change	Dead	
Row 1L	Small, off color, slight leaf spotting	Slightly wilted, except at tip	Dead	
Row 2A	Small, off color, slight leaf spotting	No change	Color good, growing well	O. K.
Row 2B	Almost dead, leaves badly curled, wilted	Dead		
Row 2C	Growth fair, slightly off color	No change	Doing well	O. K.
Row 2D	Spindling growth, no sign of attack	Color good, lower leaves slight spotting	Doing well	O. K.
Row 2E	Good growth, top good, bottom off color	Color better, slightly wilted	Color good, growing.	O. K.
Row 2F	Small, off color, lower leaves badly spotted	Leaves curling	Much improved, starting growth	Good growth, good color.
Row 2G	Off color, tip good, other leaves spotted	Leaf spotting is spreading	Dead	
Row 2H	Small, off color	Slightly wilted	Dead	
Row 2I	Badly wilted, leaves off color	Dead		
Row 2J	Dead			
Row 2K	Dead			
Row 2L	Slightly off color, growth good	No change	Dead	
Row 3A	Small, lower leaves slightly spotted	No change	Doing well	O. K.
Row 3B	Off color, slight spotting lower leaves	Worse	Much improved, growth started	Color and growth good.
Row 3C	Off color, very slight leaf spotting.	Worse	Much improved, growth started	Doing fine.
Row 3D	Color Good, very slight leaf spotting	Slightly wilted	Doing well	O. K.
Row 3E	Color fair, no spotting	No change	Doing well	O. K.
Row 3F	Color and growth good	No change	Fine	O. K.
Row 3G	Color very good, leaf spotting	Wilted	Dead	
Row 3H	Slightly off color, considerable leaf spotting	Wilted badly	Dead	
Row 3I	Color and growth very good	No change	Dead	
Row 3J	Color and growth very good	No change	Dead	
Row 3K	Color and growth very good	No change	Dead	
Row 3L	Color and growth very good	No change	Dead	
Row 4A	Small, slightly off color	Color improved, some leaf spotting	Barely alive	Dead.
Row 4B	Color fair, slight leaf spotting	Better	Doing well	O. K.
Row 4C	Color fair, lower leaves badly spotted	No change	Doing well	O. K.
Row 4D	Color fair, slight spotting lower leaves	No change	Doing well	O. K.
Row 4E	Color and growth very good	No change	Badly wilted, off color	Barely alive, removed.
Row 4F	Color and growth very good, slight spotting	No change	Doing well	O. K.
Row 4G	Color good, slight spotting lower leaves	Slightly wilted	Dead	
Row 4H	Color and growth very good	No change	Dead	
Row 4I	Color and growth very good	No change	Dead	
Row 4J	Color and growth very good	No change	Dead	
Row 4K	Color and growth very good	No change	Dead	
Row 4L	Color off, growth very good	No change	Dead	

On May 12, the portion of the frame treated with formaldehyde and the checks were removed. The plants treated with the ammonia water solution seemed entirely over the effects of the nematode injury; were growing nicely, and producing fruit.

Steam Sterilization is highly recommended, and where conditions permit the installation of the necessary apparatus, this treatment is advocated. Bessey[28] gives a summary of the treatment as follows:

"At the bottom of the bench or bed are laid either iron pipes perforated with $\frac{1}{8}$ inch holes every few inches or drain tiles. Live steam is passed into these and escaping from the holes of the iron pipes or between the ends of adjacent tiles, heats the soil to such a degree that all animals and most plants (except, of course, bacterial spores) are killed. The pipes must be placed at intervals short enough to permit the spaces between the rows of piping to be thoroughly permeated by the steam. This distance varies with the soil, but 12 inches is close enough for all general purposes, and even 2 feet is not too far in deep beds if the sterilization is kept up long enough. The bed should be covered with straw, boards, sacking, or something of the kind, to permit the upper layer of soil to become heated through. The pipes or tiles in the soil should be arranged lengthwise in the beds, with the steam inlet in a crosspiece of piping running across the bed, from which the longitudinal rows take their origin. A similar crosspiece at the other end may be used, but is not absolutely necessary. There should be no open ends of pipes or tiles; otherwise all the steam will escape out of these and not through the cracks or small holes. Depending upon the pressure of steam used, the time necessary for sterilization will vary from half an hour to even two hours when the pressure is poor.

"A method often recommended to determine whether the steam has passed long enough, and one that has considerable merit, is to bury raw potatoes at the surface of the soil underneath the covering of straw, boards, or sacking. When all these potatoes are found to be cooked the steam can be safely turned off. Stone and Smith recommend the use of a special boiler so that steam at fairly high pressure can be used, not under 40 pounds per square inch, preferably more. Even 80 to 100 pounds pressure is not too high if obtainable, as it shortens the time necessary and also prevents the soil from becoming as wet as with lower pressure.

"Not only are all nematodes killed by this treatment, but also all insects and other noxious animals, as well as all fungi and their spores. Many bacteria are killed, too, but not all of their spores, the survival of the latter being desirable in view of what we know of the value of soil bacteria.

"This method has some disadvantages. Thus, it cannot be used for beds occupied by living plants. Furthermore, care must be taken on the one hand not to leave the soil soggy and on the other not to dry it out too much. The latter is, however, a much less serious matter than the former."

Fresh Soil. In a great many cases, where the soil in greenhouse frames is infested with nematodes, the most simple practice is to employ fresh soil each year. The old soil should be allowed to dry out thoroughly for some weeks before removing it. Care should be taken to place it where there is no danger of spreading the trouble. A hard roadway is good providing there is no danger of the soil being tracked onto cultivated fields. The frames should be gone over with whitewash, freshly made from good live quicklime.

Formaldehyde. Where satisfactory soil is difficult to obtain, the infested soil may be treated with formaldehyde. For best results, this treatment must be applied when the frames are free of plants. In the greenhouse at the College a solution of two parts of commercial formaldehyde to 100 parts of water was used. Where the frames are fairly shallow, $1\frac{1}{2}$ gallons of the solution to every square yard of soil surface is sufficient. The soil should be thoroughly stirred after treatment to allow all parts to become thoroughly disinfected. The excess of formalin should be allowed time to escape before new plants are placed in the soil.

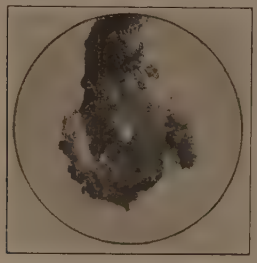


Fig. 36. Nematode gall broken open, showing female cyst in situ (enlarged).

Trap Plants. In some cases trap plants might be employed to advantage. In soil believed to be infested with nematodes where sterilization is not practical, a few hills of beets and lettuce, for example, might be planted among the tomatoes, cucumbers, or other plantings. After once the initial infestation has taken place, the trap plants should be removed and destroyed, new ones being added.

Life-History and Description.

When one of these nematode galls is broken open and the interior carefully examined, minute, glistening white, pearl-like cysts are observed here and there in the tissue (see Fig. 36). These bodies are about one-half as large in diameter

[28] Bessey, E. A., U. S. Dept. Agr. Bur. Plant Ind., 1911, Bul. 217, p. 44.

as the head of a pin. They are the mature female nematodes and the cause of the formation of the galls.

The nematode gallworms occur in the soil as minute, thread-like creatures less than $\frac{1}{25}$ inch long. When plants suitable for thier attack are present, the worms seek the growing tip of a rootlet and batter their way to the interior by means of a spear-like organ situated in the mouth. When once fixed in position, they become inactive and commence to feed and grow . The growth is mainly in thickness, and only slight in length. The larva slowly assumes a spindle shape.

After a period of about fifteen days, the form of the two sexes commences to differ. The female now assumes a flask or pear shape and is similar in appearance to the cyst observed when a gall is broken open. The male nematode transforms rapidly during this same time, and gradually assumes once more the elongate, worm-like form. It soon becomes active and seeks out the female for fertilization, after which it dies. The fertilized female continues to increase in size, and after a few days, egg laying begins. A single female will deposit 400 to 500 eggs.

Minute larvae soon emerge from these eggs. The major portion of them tunnel to the exterior of the root, crawl out into the soil and seek new plants for attack. Some of them simply work their way through the plant tissue a short distance and establish themselves in the root near the parent gall.

Summary.

The nematode gallworm is a very serious pest. It is present in adjacent States and causes untold losses by its work. It attacks the majority of our cultivated plants, stunting their growth, lessening the yield, rendering the crop unsalable, or killing the plants outright. It may be distributed in soil, or on plant roots. Nursery stock and potatoes particularly should be examined and every precaution taken to avoid planting diseased plants or tubers.

While the results of a single test are not conclusive, the success of the ammonia water treatment in our experiment warrants further trials. Until something as practical and more effective is found for treating growing plants in the frames, greenhouse men are warranted in giving this material a trial. Soil free of plants and liable to infestation by nematodes should be steam sterilized. Where this is not possible, use fresh soil or disinfect with formaldehyde. Trap plants are of some value under certain conditions.

Literature Cited.

1911. Bessey, E. A. Root knot and its control. U. S. Dept. Agr., Bur. Plant Ind. Bul. 217.

1913. Childs, Leroy. Root knot—cause and control Calif. State Com. Hort. Monthly Bul. II, 12, p. 737–756.

1911. Doten, S. B., and Frandsen, Peter. The potato eelworm. Nev. Agr. Exp. Sta. Bul. 76.

1912. Schofield, C. S. The nematode gallworm on potatoes and other crop plants in Nevada. U. S. Dept. Agr. Bur. Plant Ind. Cir. 91.

1896. Selby, A. D. Investigation of plant diseases in forcing house and garden. Ohio Agr. Exp. Sta. Bul. 73, p. 221–246.

1906. Selby, A. D. Soil treatment for the forcing house. Ohio Agr. Exp. Sta. Cir. 57.

1898. Stone, G. E., and Smith, R. E. Nematode worms. Mass. Agr. College, Hatch Exp. Sta. Bul. 55.

TIPULID WORK IN PRUNE WOOD.

Ctenophora angustipennis Loew.[29]

By A. L. LOVETT.

Larvae of a tipulid were observed during March, 1914, tunneling in the decayed wood of prune trees in an orchard near Corvallis. Many of the trees are split and have bolts drawn through them to support them. Others show great ragged deadened areas from the main crotch to the ground, where large limbs have been split off (see Fig. 00). The dead wood extends to the heart of the tree. In some cases the limb has snapped short off in the crotch (see Fig. 00). Here we have a fairly small opening, the interior of which, including the heart wood, is deadened and decayed.

The work of the tipulid larvae, while secondary in nature, was fairly serious and would certainly aid in shortening the life of the infested trees. Some brief field observations and life-history notes were taken and are included here.

Field Notes.

In those instances where the limb is broken short off, leaving a small hole leading to the rotten heart wood, the Tipulidae were found in abundance. Where the limb is split off from the crotch of the tree to the ground, leaving the whole side of the tree dead and exposed, only an occasional specimen occurs. It is here, however, that the individual larval tunnels can be more readily followed. These larval tunnels extend from above downward with long, easy curves, increasing slowly in size as the larva develops. They are from eight to 26 inches in length and from one to 2½ inches across. These tunnels are nearly filled with frass.

The mature larvae and pupae were usually located at the bottom of the tunnel. The pupae are provided with circles of well-developed spines and it is reasonable to suppose that they work their way up the tunnel through the frass to near the surface about the time the adult is to emerge. While it is impossible to follow the individual tunnels in those instances where the limb if broken off short, the interior being simply a mass of frass and wormwood, the abundance of material afforded some interesting observations. The insects were apparently more advanced here. Mature larvae, pupae, and several adult males were present. It is evident that, as with other allied species of Tipulidae, the males emerge first and wait about for the appearance of the females.

These tunnels all through the deadened wood afford more ready entrance for the moisture from our winter rains. The frass helps to hold this moisture and in this way assists decay. To this extent the work of this insect is of economic importance.

An allied species, *Ctenophora apicata* O. S. is reported from Maine[30] as working in the decayed wood of the elm.

Probable Life-History in Field.

There is probably one generation each year.[31] The adults appear during late March and April and deposit eggs very soon after mating. The life of the female is probably from four to 10 days. The number of eggs deposited by a single female is from 200 to 400. These are probably deposited in cracks and crevices in the areas of dead wood of the tree. The larvae hatch in from nine to 17 days, and tunnel into the surrounding dead wood. They feed and grow, maturing the following spring. They transform to pupae in the bottom of the tunnels which the larvae have formed. The pupal stage is about 10 days.

[29]Loew, Herrmann, Dipt. Amer. Sept. Indig. Berl. Ent. Zeit. Cent., 1872, X, 3.

[30]Johannsen, O. A., Maine Agr. Exp. Sta., 1909, Bul. 177, p. 32.

[31]The duration of the egg and pupal stage and the length of life of the female are figured on the basis of breeding-cage records.

Plate VI.

Plate VI. Wood-Boring Tipulid (*Ctenophora angustipennis* Loew.). 1. Adult crane flies. 2. The egg. 3. Pupae. 4. The larva 5. Eggs in decayed prune wood as deposited in breeding cage. 6 and 7. Prune trees showing characteristic types of injury. 8. Prune tree with outer deadened area removed to show larval tunnels of tipulid.

Laboratory Notes.

Specimens of larvae, pupae, adult tipulids, and decayed prune wood were brought into the laboratory for study. Two pairs of adults were studied to determine the number of eggs deposited by a single female and the length of the egg stage.

Couple No. 1, March 28, 1914. A freshly emerged female was placed in a vial with a male in the field and transferred to the laboratory.

Couple No. 2, April 1, 1914. A pair were captured in copulation in the field and brought to the laboratory for study.

Table VII.

Couple	No. Eggs	Deposited	Hatched	Egg Stage	Remarks
	116	Mar. 28	Apr. 14	17 days	
	141	Mar. 30			Moldy, no hatch.
No. 1	120	Mar. 31	Apr. 16	16 days	
		Apr. 1			
		Apr. 2			Female dead.
	28	Apr. 2	Apr. 13	11 days	
No. 2	78	Apr. 3	Apr. 13	10 days	
	84	Apr. 5	Apr. 14	9 days	
		Apr. 6			Female dead.

The total number of eggs deposited by female No. 1 was 377; by female No. 2 was 190. There was every indication, however, that female No. 2 had deposited eggs in the field previous to being brought to the laboratory. It will be noted that the number of days for the egg stage decreased toward the last. This was due to improved methods for handling. The earlier eggs were placed in part in a dry cell and in part in a moist cell. The former would shrivel up and the latter would mold. The later eggs were half submerged in water. Some of the early eggs which had shriveled badly were placed in excessive moisture and assumed their normal shape in a short time. None of the newly hatched larvae were bred to maturity.

Description.

The Egg. Ebony black with deep purple reflection. Elongate oval, uniform, without pits or ridges. Length 1.26 mm. to 1.4 mm., at widest point .575 mm.

The Larva. 39 mm. long, 5.2 mm. wide when mature; general color dirty, slightly brownish white. Body walls semi-transparent showing fat bodies and food particles. Body composed of 13 segments; head partly incased in first segment and retractle within first two segments. Anal segment with four slightly elongate tubercles arranged radially just in front of and projecting slightly over, two large, prominent, black spiracles. When body is contracted, tubercles completely hide spiracles. Posterior of spiracles are two small,

Fig. 37. Anal segment of larva of *Ctenophora angustipennis* (enlarged).

blunt tubercles rounded posteriorly, flattened and inclined slightly anteriorly. A small, black spiracle at base of flattened anterior face. Segment terminates in rounded pseudopod (see Fig. 37).

The Pupa. Cylindrical, slightly sinuate from lateral aspect. Length 26 mm.; diameter 3 mm.; wing covers, legs and antennae free, appressed to venter. General color dirty white; head, wings, antennae, and legs light brown. Head well defined. Pronotum with pair of short spatulate respiratory tubes directed laterally. Two pair of short heavy spines on the dorsal surface. Abdomen composed of eight segments, the first short, with two pairs of short transverse dorsal spines. The other segments except anal segment with same general arrangement, but spines often paired, not uniform, sometimes with short inconspicuous spines between. Ventrally first and second with two short spines; third, fourth, and fifth usually with three very prominent spines; sixth and seventh with from three to five spines. One small spine on posterior lateral margin of each segment, on fleshy tubercle on last one.

Anal segment rather complicated; three pair of transversely placed, rather prominent, fleshy tubercles. Two pair on dorsal surface, one pair on posterior part of ventral surface. First pair above centrally located, wide apart, flattened and directed dorsalward. Posterior pair close together, more fleshy, longer, and slightly inclined forward. Both pair armed at tip with inconspicuous spines. Pair on ventral surface heavy, joined directed posteriorly. Just anterior of these tubercles are two pair of conspicuous spines. The segment terminates in a well-defined, slightly blunted tip with dorsal V-shaped opening.

The Adult. Williston[32] describes the adult male as follows:

"Head and antennae black, the palpi and second and third antennal joints yellow. Antennae about as long as the mesonotum, the pectinations scarcely exceeding the antennal joints in length. . . . Mesonotum yellowish red; the lateral margins and a spot in the middle behind black; the humeral callosity; the pronotum, and a stripe on the upper part of the plurae, running through the root of the wings, yellow. Scutellum on the sides, the upper part of the metanotum, and the meta-pleurae in front of the halteres, yellow; scutellum and plurae, otherwise, black. Abdomen yellowish red, with a continuous black stripe, expanded on the posterior margin of each segment. Legs yellow, the extremity of the femora and tibiae, and the distal three or four joints of the tarsi, dark brown. Wings light amber color. Length 17 to 20 mm."

To this I add:

Female. Head black, antennae and palpi except tips, yellow; the proximal segment of antennae black. Antennae about one-half as long as in male; pectinations very short. Thorax in color similar to male. Abdomen same general color as male. In both there is a broad, black band on posterior margin of first segment. The black dorsal stripe hardly so pronounced, often disappearing on sixth segment. Length 20 to 25 mm. (see Plate VI.)

Control Methods.

While no work was undertaken for the control of this insect, it would appear that the careful dressing of wounds and the painting over or otherwise protecting of all large scars and bruises on trees would be advisable as a precautionary measure against it.

[32]Williston, S. W., Kansas Univ. Quar., 1893, II, No. 2, p. 63.

THE TOMATO WORMS.

Phlegethontius sexta Johan.
Phlegethontius quinquemaculata Haw.

By A. L. LOVETT.

There are two species of large, naked, green, horn-worms which attack the foliage of tomatoes and potatoes in Oregon. As a rule they are not numerous enough to be of especial economic importance. The past season, however, there were local outbreaks of one or the other of these worms in several different sections of the State. The attacks varied in severity, but in some cases large areas of potatoes were defoliated and whole plantings of tomatoes were practically ruined.

Control Measures.

Hand picking or knocking them into a pan of soapsuds with a paddle is the standard treatment for these worms in gardens, where they occur in limited numbers. Their large size renders them conspicuous, and incidentally makes extra heavy doses of poison necessary to kill them. Where they are present in great numbers, or where they are discovered while yet small, use an arsenical dust, one part of powdered acid arsenate of lead to twenty parts of dust.

Be sure to get the diplumbic or acid arsenate of lead. Triplumbic is too slow in its action. The ideal dust to use with this poison is finely sifted wood ashes. Road dust, sulfur and air-slaked lime are really too heavy but can be used. For large areas some type of powder gun should be used. The newer types with a nine-inch fan-wheel are best. A smaller gun or even a coarse sack may be used for dusting small areas. The dust should be applied in the early morning, while the dew is on.

Fall or early spring plowing will destroy many over-wintering pupae in the soil. As they go down to a depth of two to four inches, one must plow deep in order to get them. Turkeys allowed to range over the infested field will do most efficient service in harvesting the worms.

The Species Involved.

The two species which are present in Oregon are known as the tomato worm or the tomato sphinx, *Phlegethontius sexta;* and the tobacco worm or the tobacco sphinx, *Phlegethontius quinquemaculata.*

The mature worm is about three inches long, hairless, light green in color, and with a curved horn or spine near the hind end. The tomato worm has seven oblique light markings on each side of the body. The tobacco worm has eight of these markings and the oblique line is extended backward horizontally at the base to form a V.

The pupae are known as jug-handled pupae. The handle or tongue that accounts for the name is longer in the chrysalis of the tobacco worm. The chrysalis is about two inches long and of a rich brown color. (See Plate VII).

The adult moths are of about the same size. The general color is gray with lighter markings on the wings and orange or yellow spots on the abdomen. The body is about two inches long and the moths have a wing expanse of four to five inches. The tobacco worm moth has the more pointed abdomen, and the abdomen has but four pairs of orange spots (see Fig. 38 B). The general color of the tomato worm moth is duller, the white markings being less distinct. The abdomen has six pairs of orange spots (see Fig. 38 A).

Food Plants.

Tomato, potato, eggplant, tobacco, and various Solanaceae form the major part of the food of these worms. Specimens of *P. sexta* were received from Salem, Oregon, reported as feeding on cherry foliage. Specimens of *P. quinquemaculata* were collected near Redmond, Oregon, feeding on poplar.

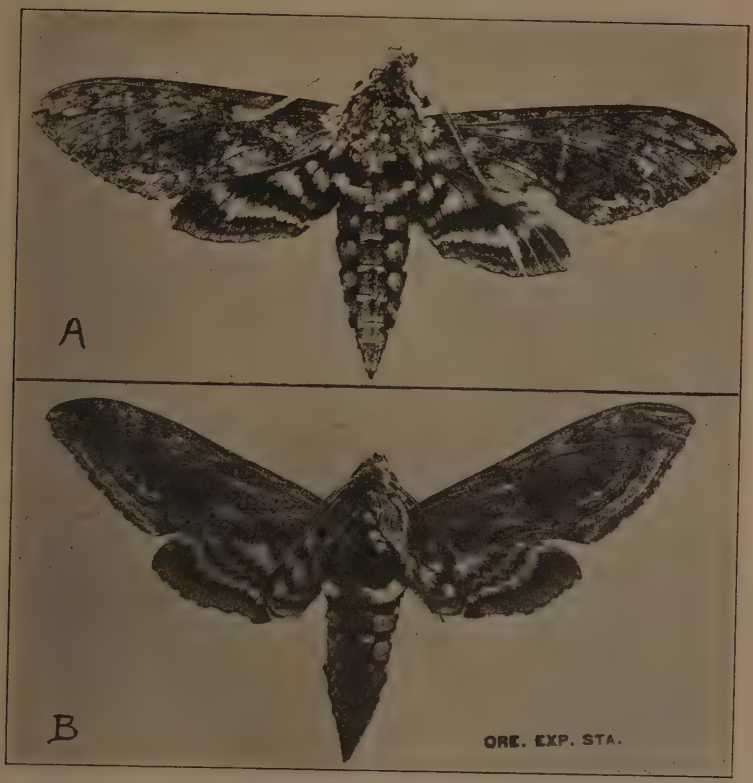


Fig. 38. A, adult moth of the Tomato Worm (*Phlegethontius sexta*); B, adult moth of the Tobacco Worm, (*P. quinquemaculata*).

Life-History.

The adult moths emerge during May and June. In fact, moths continue to emerge from over-wintering pupae for a month later than this. The earlier maturing worms are full grown in late July. They enter the soil to a depth of two inches or more when they pupate. There is an incomplete second generation of moths from these early maturing forms. They emerge during August and produce part of a generation of worms. The majority of the worms develop more slowly, mature late in the summer, and remain in the chrysalids in the soil until the following spring.

Natural Enemies.

From specimens of *P. quinquemaculata* larvae sent in this summer, a great number of Tachinid flies emerged. Prof A. L. Melander kindly determined them as *Sturmia inquinata* Wied.

Mature worms are often found with the body covered with little white egglike bodies. These bodies are the cocoons of a little parasite, *Apanteles congregatus*, larvae of which feed inside the body of the worm.

A bacterial disease sometimes attacks these worms, causing them to shrivel up, turn black, and die.

Plate VII.

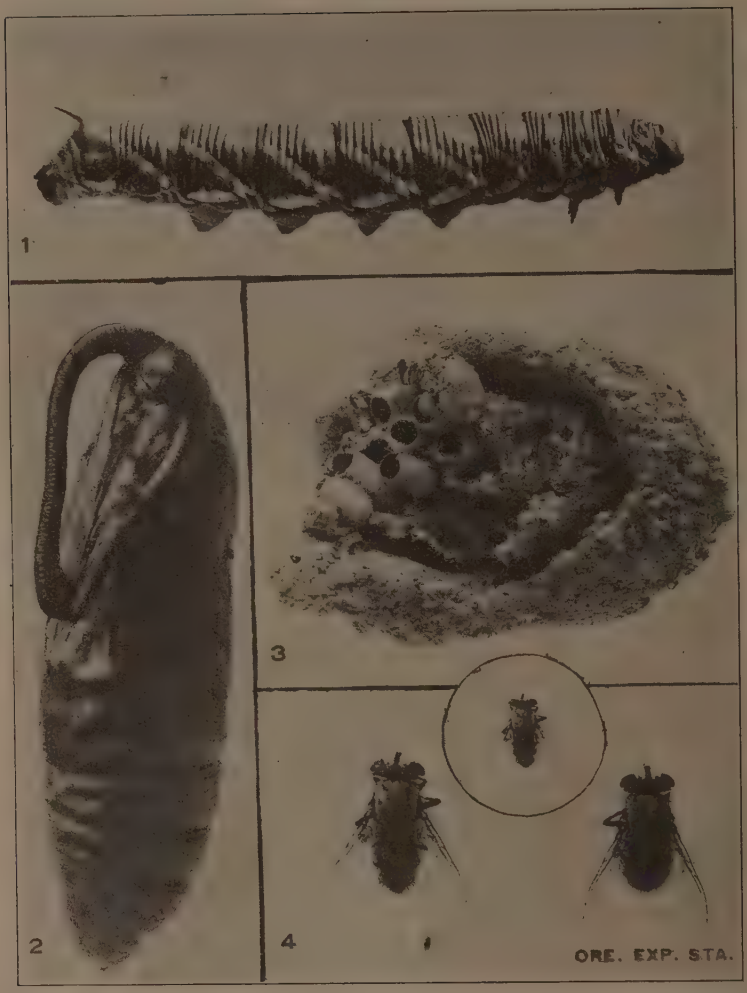


Plate VII. The Tobacco Worm (*Phlegethontius quinquemaculata*). 1. The mature worm. 2. The pupa (enlarged). 3. Pupal cell in soil, showing condition of parasitized form. Observe puparia of parasite. 4. Tachinid fly parasite (*Sturmia inquinata* Wied.) (Natural size and twice enlarged.)

THE ANTIQUE OR RUSTY TUSSOCK MOTH.

Notolophus antiqua Linn.

By L. G. Gentner.[33]

Order Lepidoptera. Family Laparidae.

Introduction.

On account of the abundance of the antique tussock moth, and the ease with which material for study can be secured in the vicinity of Corvallis, an investigation of this insect was thought to be a fitting subject for my graduation thesis. The work was begun in the spring of 1914, and is still under way (December, 1914). The principal object of the study was to work out the life-history and methods of control.

During the course of study, a number of interesting things have been observed. The most interesting fact is the development of a third complete generation, in the laboratory, from one of the egg masses used. The larvae from a second mass of eggs are now in the third instar of the third generation. Another interesting feature is the discovery of the apparent development through parthenogensis. This has already been mentioned by Barnard in 1880. He, however, bases his statement on the fact that "all winter brood are females, and must reproduce without the co-operation of the male." Observations made at Corvallis show that both males and females are produced in the fall generation. In most cases the larvae passed through five molts from the time of hatching to pupation. In one case, however, a male larva passed through only four molts, and in another case, a female larva passed through six molts. This was observed by Hellins in 1882. He did not take into consideration the molt at the time of pupation.

Life-history studies have been carried on in detail under laboratory conditions, and have been checked by numerous observations out of doors. The first generation developed more rapidly under laboratory conditions than in the field. There was only a slight difference between the second generation in the laboratory and in the field. No development of a third generation in the field has been observed. A more complete technical discussion of this insect will be given in the completed thesis. The common names applied to this insect are the "rusty tussock moth", "antique tussock moth", "vaporer moth", "old tussock moth", and "European tussock moth."

Classification and Synonymy.

When first described by Linnaeus, in 1758, this insect was placed in the genus *Bombyx*. In 1831, Miss Dix writes about this insect under the genus name *Phalaena*. Various writers since 1864 have placed it in the genera *Orgyia* and *Notolophus*. In 1894, Neumoegen and Dyar, in their "Preliminary Revision of the *Bombyces* North of Mexico", place it in the genus Notolophus; and Dyar, 1902, in his "List of North American Lepidoptera", retains it in that genus.

Notolophus antiqua has been described in several distinct species. In 1865, Fitch described it as *Orgyia nova* or the new tussock moth. He states that the wings of the male are more darkly clouded than in antiqua, and that the larvae had two bright red tubercles on the sixth and seventh abdominal segments. The latter character, he claims, cannot be found for the antique tussock moth. In 1904, Miss Patch mentions the presence of these tubercles on antiqua. This fact is also mentioned by Woods in 1906, by Sanderson in 1908, and by Comstock in 1909. In the work carried on here, the presence of the above mentioned tubercles were found on all the larvae.

In 1874, Edwards describes *Notolophus antiqua* as *Orgyia badia*. His chief distinction was that in antiqua the fore wings were nearly unicolorus, and that in badia they were much paler centrally. In the experiments carried on here, both types of adults have been obtained.

[33]Mr. Gentner, a senior student in the department of Entomology, was requested to prepare this abstract from his thesis because of the economic importance of this insect in this state. H. F. W.

History.

This insect is a native of Europe, and was probably brought to this country on imported fruit trees. The only definite statement found to this effect was that of Parrott, 1909, who states that the eggs were found on seedlings imported into New York. However, it was reported as early as 1831, by Miss Dix, as being found in Rhode Island and Maine. Perkins, 1877, reports its presence in Vermont. Fletcher, 1907, states that in Nova Scotia the larvae eat the foliage and gnaw holes in the growing apples. Cooley, 1910, reports that the season of 1909 was the first in eleven that the insect had been abundant. Its presence in British Columbia was reported in 1914.

The insect seems first to have been introduced on the Atlantic Coast and then to have spread gradually to the Pacific Coast. It is very probable that it was known to occur in certain parts of the country long before it was reported, but due to the fact that it is not usually a serious pest, it was not mentioned.

Distribution.

This insect is found in nearly all parts of Europe, England, northern United States, and Canada. It was noted in Rhode Island and Maine in 1831 by Miss Dix. Riley, 1880, states that a cocoon sent in to him for identification was that of *Orgyia antiqua*. This cocoon had on it an egg mass enclosed in a frothy covering, and could therefore not have been that of antiqua. The eggs of antiqua never have a covering. In the same year Barnard mentions the antique tussock moth as feeding on willow. Again, the egg masses were said to be enclosed in a frothy mass, and must have been those of some other species. It was reported from Nova Scotia by Fletcher in 1907; from Canada, east of Toronto, by Saunders in 1909.

Occurrence in the Northwest. This insect occurs quite abundantly in Oregon, although not in large enough numbers to cause wholesale injury. In 1914, it was reported from British Columbia. No report has been made of its presence in Washington, but it is possible that it occurs there also.

Nature and Extent of Injury.

It is during the larval stage of this insect that the injury occurs. This is of two kinds. The larvae feed on the foliage, and also gnaw holes into the sides of growing apples. This latter form of injury, however, is rare. After hatching, the larvae feed for some time on the eggshells, then begin to feed on the upper surface of the leaves. As they become older and increase in size, they feed more

Fig. 39. The Antique Tussock Moth (*Notolophus antiqua*); a, larva; b, egg; c, pupa of female; d, pupa of male; e, cocoon; f, female and egg mass on cocoon; g, adult fema e; h, male.

heavily, later eating entire leaves, with the exception of the midrib and larger veins. As a rule they are not abundant enough to do serious damage, but occasionally they may become sufficiently numerous to strip the trees of a large part of their foliage.

Life-History.

The winter is spent in the egg stage. The egg masses are found fastened to the old cocoons on the trunk and branches of the trees, and on old leaves on the ground. The eggs hatch in the spring from the first part of April to the first of May. The larvae reach maturity and pupate from about the later part of May to the middle of June. The insect remains in the pupal stage for several weeks, the first pupae emerging about June 24 and the last about the first week in July.

After emerging the female remains on the old cocoon, where copulation with the male takes place. Egg deposition begins almost immediately after fertilization, the eggs being deposited in a mass on the old cocoon. In from 10 to 12 days these eggs hatch, giving rise to a second generation. These larvae feed for some time on the egg shells, then on the foliage, in a manner similar to those of the first generation, but they develop in a somewhat shorter time. By the first part of September practically all of the larvae have pupated. The adults begin to emerge about the middle of September and continue to emerge throughout the month. The females are fertilized by the males and then deposit the eggs, which remain over winter on the cocoons.

The Egg.

The eggs are laid in a mass, one layer deep, upon the cocoon from which the female has emerged. Each mass generally contains from 200 to 300 eggs, but masses have been found to contain as high as 600 eggs. The eggs are usually in regular rows and do not have any covering as is the case in allied species.

Description. The egg is about 1 mm. in diameter, spherical, the top slightly flattened and depressed. Around this sunken or depressed area there is a dark ring. When first deposited, the egg is of a cream color, but soon turns to a dirty gray. The shell of the egg is thick and brittle.

The Larva.

The larva, in emerging from the egg, begins to eat through at the central part of the depressed area of the egg, increasing the size of the hole until it is large enough to permit it to escape. At this time the hole usually extends almost to the dark ring. After leaving the shell, the young larva feeds on it for some time, often completely devouring it. It then begins feeding on the foliage. At first it feeds only on the upper surface of the leaf. About a week after emergence entire areas are eaten out; and finally entire leaves, with the exception of the midrib and larger veins, are destroyed.

It is characteristic of the young larva when disturbed to suspend itself by a silken thread. When the danger is over, it draws itself up by means of this thread and resumes its feeding. If touched at any time while at rest or feeding, it will curl up in a ball.

The larva passes through a series of five molts covering a period of five to eight weeks. The fifth molt takes place at the time of pupation, and after the cocoon is spun. After the third molt, the female larva grows much more rapidly than does the male larva. It is after the fourth molt that the larva attains its full growth. The male pupates several days before the female. The larval stage of the second generation is of shorter duration than that of the first. The time between molts, given in the following description, is from records obtained under laboratory conditions.

Description of Instars.

First Instar. The larva, when first hatched, is about 2 mm. in length. It is yellowish with a black head and with long, yellowish hairs. Within a day the color changes to brownish black.

Second Instar. The first molt occurs about eight days after hatching. The larva is then about 4 mm. in length; general color black. On either side of the first thoracic segment is a distinct knob or tubercle, bearing long, black hairs. The second and third thoracic segments are white, dorsally. The first, second, third, and fourth abdominal segments are black; the fifth segment white, dorsally; the sixth and seventh black with a distinct orange tubercle located centrally on the dorsum of each. The eighth segment has a knob or tubercle on the dorsum, bearing long, black hairs; ninth segment black. The entire body covered with black and whitish hairs.

Third Instar. The second molt occurs about seven days after the first, and 15 days after hatching. At this time the larva is about 7 mm. in length. On either side of the first thoracic segment is a tubercle, black at the top and orange at the base. Each tubercle bears a compact pencil of long, black hairs about 1 mm. in length. This pencil is surrounded by scattered black hairs, measuring about 4 mm. in length. The second thoracic segment has two distinct, whitish square areas dorsally placed and each bearing a short tuft of whitish hairs. The third thoracic segment has a white patch which merges into faint orange near the lateral edges. The first, second, third, and fourth abdominal segments each have an oval-shaped black area surrounded by a border of orange, tinted with white.

From the center of each of the patches on the first and second segments arises a compact, grayish tuft about ¾ mm. in length; and from the center of the patch of the third and fourth segments a white tuft about ½ mm. in length. The fifth segment is dorsally covered with a patch of white having an orange tinted border. The sixth and seventh segments are black, bearing, centrally, a distinct, small, circular, orange-colored tubercle. The eighth segment is black with a tubercle bearing a compact pencil of black hairs slightly less than 1 mm. in length. The ninth segment is whitish gray. Each segment bears on its sides tubercles, from which arise tufts of whitish hairs intermingled with blackish hairs. These tufts measure about 2 mm. in length.

Fourth Instar. The third molt occurs about six days after the second, and 21 days after hatching. The male larva is about 9 mm. and the female larva about 11 mm. in length. The pencils on the first thoracic segment are 3 mm. in length, and each hair is now feathered near the tip. Between the two pencils are two flat tufts of whitish hairs, 1½ mm. in length, and extending forward over the head. A broad, black, velvety stripe runs longitudinally along the center of the dorsum, except on those segments having white patches. On either side of the black stripe there is another stripe, nearly as broad, dark purplish-gray in color. In each there is also a row of pale orange tubercles, one to each segment, bearing tufts of whitish hairs intermingled with a few black hairs slightly longer. Adjacent to this stripe, on either side, is a narrower, whitish stripe, including a second row of tubercles similar to those of the first row, but more brownish in color. Then comes another grayish stripe, on either side, reaching to where the legs and prolegs join the body. This includes tubercles similar to those of the second row, but smaller.

All tubercles bear tufts of hairs. The pencil on the eighth abdominal segment is more compact than those on the first thoracic segment, and is about 2 mm. in length. The hairs are feathered near the tip. The orange tubercles on the sixth and seventh segments are present, but have not increased in size. The brushes on the first and second segments are whitish gray, while those on the third and fourth segments are yellowish in color. The legs and prolegs are light gray.

Fifth Instar. The fourth molt occurs from six to seven days after the third, and from 27 to 28 days after hatching. The male larva is about 14 to 15 mm. in length, while the female larva is about 18 to 20 mm. in length and much stouter. The general body color is a purplish gray. There is a black, dorsal stripe running longitudinally. The first row of tubercles on either side is bright orange, while the second and third rows are paler in color. Between the first and second rows of tubercles on either side, running longitudinally, is a narrow, broken, black line, with light blotches below it where the segments

join. The white brushes on the first, second, third, and fourth abdominal segments terminate in a neat point.

On either side of the second segment is a black pencil, similar to, though shorter than, those on the first thoracic segment, and extending straight out from the side of the body. These two pencils distinguish the larva of the species antiqua from the larva of other species of *Notolophus*. Dorsally on the fifth segment there are two bright orange markings. There is a small, bright orange tubercle, centrally, on the dorsal side of the sixth and seventh segments. The color of the female larva is not as bright as that of the male. In the first generation the male larva attains a length of about 20 to 24 mm. and the female larva about 25 to 32 mm. In the second generation the male larva attains a length of about 25 to 32 mm. and the female larva about 32 to 37 mm.

Pupa. The fifth molt occurs after the larva has spun its cocoon, and just at the time of pupation. This is about six days after the fourth molt and about 33 to 34 days after hatching.

The Cocoon.

When the larva is mature and ready to pupate, it seeks a hiding place on the trunk of a tree, on a branch, or among leaves. It then spins a large, loose, outer covering, within which it constructs a smaller, closely woven sack Within this sack the last molt occurs and the insect transforms to the pupa.

Description. The size of the cocoon varies according to the larva and the conditions under which it is spun. The average length is about 20 mm.; average width about 10 mm. The male cocoon is smaller than that of the female. The outer portion consists of a loose whitish covering made of silken threads, intermingled with the long, black hairs from the body. Within this is a much smaller, somewhat more closely woven covering or sack, in which the shorter hairs of the body are interwoven.

The Pupa.

The pupa of the male is much smaller than that of the female and the pupal stage is longer. The pupal stage of the first generation is about 14 to 17 days for the female, and about 20 to 24 days for the male. The pupal stage of the second generation is seven to nine days for the female, and 11 to 12 days for the male.

Description. Both male and female pupae are at first pale yellowish green in color, later becoming black with brown and yellow tints. The ventral surface is smooth; the dorsal surface is covered with short, fine whitish hairs, and also shows the places where the four white brushes occurred on the first, second, third, and fourth abdominal segments of the larva.

Male Pupa. 11 to 13 mm. in length, by about 4 mm. in width. On the ventral side one can plainly see where the eyes, wings, and feathered antennae of the future adult lie by the outline of the raised portions of the pupal case. The general color of the pupa is brownish black. (The shade varies, being much lighter in some specimens.) The edges of the raised portions and the greater portion of the posterior third of the pupa are brownish yellow in color.

Female Pupa. 17 to 20 mm. in length by 6 to 7 mm. in width at the widest part; slightly flattened on the ventral side. Looking down upon it, dorsally or ventrally, it appears oval in shape, tapering toward both ends. The positions of the eyes, antennae, and rudimentary wings are plainly visible on the ventral surface of the pupal case. The general color of the female pupa is lighter than that of the male.

The Adult.

The adult moths do not feed. The males usually emerge a day or two earlier than the females. The wingless females crawl out of their cocoons, and remain hanging to them until the eggs are deposited. The males and females copulate (?) and the females very soon afterward begin depositing their eggs.

Plate VIII.

Plate VIII. The Antique Tussock Moth (*Notolophus antiqua*). 1. Female laying eggs. 2. Spent female and young larvae just hatching. 3. Mature larva. 4. Pupae of, left, male; center and right, female. 5. Female just emerged. 6. Male. 7. Adult hymenopterous parasite (*Dibrachys boucheanus* Ratz).

The greater part of them are deposited the first day; some the second; and a very few the third day. During this process the females shrivel up to about one-third their original size.

When the eggs have been deposited, the spent females drop from the cocoons. They usually die from 10 to 12 days after emerging. The males live for about five to seven days after emerging. In some cases the unfertilized females remain suspended from their cocoons for about three to five days, then deposit eggs scatteringly and in bunches, and finally drop to the ground without having deposited all of their eggs. In other instances they deposit the eggs in the same manner as the fertilized females.

Description.

The Male has a wing expanse of about 26 to 33 mm. The wings are of a rusty brown color. The forewings are crossed by two broad, dark, wavy bands, one near the body and the other near the distal edge. Near the costal margin, in the light area between the two dark bands, are two V-shaped, dark brown markings, one behind the other. The points are toward the body when the wings are spread. Near the anal angle there is a distinct, white crescent. The antennae are 3 to 4 mm. in length and broadly feathered. They are brownish in color. The thorax and abdomen are brown in color and covered with rusty brown hairs. Those on the thorax are much longer than those on the abdomen.

The Female is without wings and measures 11 to 14 mm. in length by about 5 or 6 mm. in width. Through long disuse the wings have degenerated to mere rudimentary wing pads. The thorax and abdomen are not separate, but are fused into one mass, causing the female to resemble closely an animated sack of eggs. The body is grayish black in color, covered with short, gray to grayish-yellow hairs. Dorsally the female appears to have a dark stripe running longitudinally with the body. This is due to the fact that the hairs here are less numerous and the body color shows through. The antennae are about 4 mm. in length, thread-like and only slightly feathered.

Food Plants.

This insect feeds upon the foliage of almost every kind of tree, shrub or herbaceous plant. In Europe it has been reported as feeding on plum, apple, mountain ash, rose, apricot, raspberry, bilberry, heath, hornbeam, hazelnut, alder, willow, beech, birch, oak, pine, and other plants. In this country it has been reported as feeding on apple, plum, quince, thorn, rose, aspen, birch, larch, thorn-hedges, and poplar-leaved birch. In Oregon it feeds principally on apple, pear, cherry, and other fruit trees.

Natural Enemies.

Two parasites, a Tachinid fly and an Ichneumon fly (*Pimpla inquisitor*) were reported by Woods in 1906, the latter being reported as destroying whole colonies while in the pupal stage. These parasites are in turn attacked by other parasites and so cannot be depended upon as a means of complete control.

Fitch, 1865, describes a Hymenopterous insect (*Telenomus orgyiae*) as being parasitic on the eggs. He states that the insect punctures the eggs of the host and inserts one of its own eggs. The larva on hatching feeds on the egg substance.

At Corvallis, during the past season, a number of the female pupae were found infested with numerous small larvae. These pupae seemed to be entirely filled with the larvae, which could be seen through the pupal case. These pupated within the pupal case of the host and on emerging proved to be Hymenopterous parasites (*Dibrachys boucheanus* Ratze.)

Methods of Control.

Many writers recommend gathering the egg masses during the dormant season and destroying them. At this time they may easily be found attached

to the trees or on dead leaves. When very numerous, the larvae may be jarred from the trees and prevented from returning, by placing sticky bands around the trunks.

It has been observed in Oregon that, where the orchards are regularly sprayed with arsenicals, this insect does not become serious. The best time to spray is a short time after the hatching of the eggs, when the larvae are still very small. For Oregon, this would be from the middle to late April, and if necessary, again in midsummer. The larger the larvae get, the more resistant they become to the poison. Often they are not destroyed by the ordinary strengths of the spray. In such cases heavier doses should be applied; arsenate of lead, four pounds to fifty gallons of water, being recommended.

Acknowledgments.

I am indebted to Professor H. F. Wilson, Assistant Professor A. L. Lovett, and other members of the department for suggestions in carrying on the work and in the preparation of the manuscript.

Bibliography.

1880. Barnard, W. S. The European tussock moth. Amer. Ent. (V. 3) n. s. I, p. 77, March.
1880. Barnard, W. S. Parthenogenesis in *Orgyia antiqua*. Amer. Ent. (V. 3) n. s. I, p. 227, Sept.
*1900. Busch, M. Aus dem Geschletsleben von *Orgyia antiqua*. Zeitscher. f. Entom. V, No. 5, p. 76.
1899. Carr, F. M. B. Curious instance of "assembling." The Ent. XXXII, p. 94, Apr.
1906. Comstock, J. H. Manual for the study of insects, p. 311-312.
1910. Cooley, R. A. Seventh annual report of the state entomologist of Montana. Mont. Sta. Bul. 79, p. 52-53.
*1831. Dix, Dorothea L. *Phalaena* (*Orgyia*) *antiqua*. Amer. Jour. Arts and Sci. XIX, p. 47-54, Jan.
1891. Dyar, H. G. Description of certain lepidopterous larvae. Ins. Life, III, p. 390.
1897. Dyar, H. G. *Hemerocampa* n. g. for *Notolophus*. Can. Ent. XXIX, p. 13.
1902. Dyar, H. G. A list of North American Lepidoptera. U. S. Nat. Mus. Bul. 52, p. 259.
*1874. Edwards, Henry. *Orgyia badia*. Proc. Cal. Acad. Sci. V, p. 188.
*1882 Fernald, C. H. The American vaporer moth. The Home Farm, XV, Nov.
1893. Fernald, C. H. Report on insects. Mass. Hatch Bul. 20, p. 15-16.
1865. Fitch, Asa. *Orgyia nova*. N. Y. Ent. reports, I, Pt. 2, p. 193.
1908. Fletcher, J. Report of the entomologist and botanist. Canada Exp. Farm Reports, p. 207-208.
*1905. Forbes, W. The vaporer moth, Jour. Bd. Agr. (London) XII, No. 7, p. 420-421.
*1899. Gauckler, H. Beobachtungen aus dem Geshlechtsleben von *Orgyia antiqua*. Insekten-Borse, 16 Jhg., No. 33, p. 195.
*1900. Gauckler, H. Beobachtyngen aus dem Geschlechtsleben von *Orgyia antiqua*. Insekten-Borse, 17 Jhg., No. 29, p. 227.
1903. Gibson, A. Basswood or linden insects. 34th Ann. Rept. Ent. Soc. Ont. for 1903, p. 50-61.
1864. Girard, M. Maurice. *Orgyia antiqua*. Annales de la Soc. Ent. de France L.
1865. Gouley, M. *Orgyia antiqua*. Bul. Soc. Ent. France, XXXI.
1890. Harris, Thaddeus W. Treatise on injurious insects. London.
1882. Hellins, John. On the variation of the sizes of lepidopterous eggs laid by the same female and other notes. Ent. Month, Mag. XIX, p. 210.
*1899 Krieger. Ein Falter von *Orgyia antiqua* L. Illustr., Zeitschr. f. Entom. IV, No. 13.
*1758. Linnaeus, Carolus. *Bombyx antiqua*. Syst. Nat. I, p. 503.
1877. Mabille, M. P. *Orgyia antiqua*. Bul. Soc. Ent. France, CIXIV.
1895. Meyrick, Edward. Handbook of British Lepidoptera, p. 172.
1912. O'Kane, W. C. Injurious insects, p. 295-296.
1890. Packard, A. S. Insects injurious to forest and shade trees. 5th Rpt. U. S. Ent. Com. Wash. V, p. 447-448.
1909. Parrott, P. J. Insects on imported nursery stock. Jour. Econ. Ent. II, No. 4, p. 305.
1904. Patch, Edith M. Brown-tail moth and other orchard moths. Maine Sta. Bul. 108.
1905. Patch, Edith M. Strawberry crown girdler. Maine Sta. Bul. 123, p. 213.
1906. Patch, Edith M. Insect Notes for 1906. Maine Sta. Bul. 134, p. 224.
1877. Perkins, G. H. On certain injurious insects. Rpt. Ver. Bd. Agr., p. 128-139.
No. 1, p. 10.
*1899. Reh, L. Massenhaftes auftreten von *Orgyia antiqua* A. Illustr. Zietschr. f. Entom. IV., No. 1, p. 10.
1880. Riley, C. V. Abnormal cocoon of *Orgyia antiqua*. Amer. Ent. (III) n. s. I, p. 132, May.
1908. Sanderson, E. Dwight. Caterpillars injuring apple foliage in late summer. N. H. Sta. Bul. 139, p. 220-225.
1909. Saunders, W. Rpt. of Div. of Ent. and Botany. Canada Exp. Farm Rpts., p. 61.
1896 Schoyen, W. M. Notes on insects of Norway and Sweden. U. S. Div. Ent. Bul. 9, n. s., p. 79-80.
*1899. Theobald, F. V. Hop dogs, Jour. Southeast Agr. Col. Wye. No. 8, p. 35-38.
1899. Whittle, F. G. Abundance of the larvae of *Orgyia antiqua*. The Ent. XXXII, p. 28, Nov.
1906. Woods, Chas. D. Circulars, finances, meteorology, index. Me. Sta. Bul. 137, p. 296-298.
1914. Brittian, W. H. The antique tussock moth. Proc. Ent. Soc. of B. C., No. 4, p. 14, n. s., Jan

*Those references marked with an asterisk (*) have not been seen by the writer.

THE BROWN LACEWING.

Hemorobius pacificus Banks.

By G. F. MOZNETTE.

The above species is of considerable economic importance in that it is predaceous in its larval stage upon the Aphididae or plant lice, Acarina or mites, and probably other soft-bodied insects. It was found to be particularly important in destroying the oviparous females of the rosy apple aphis, *Aphis sorbi* Kalt., and the currant aphis, *Myzus ribis* Linn. However, this species preys upon almost all species of Aphididae, and during July, 1913, it was found quite abundant in hop yards, feeding upon the wingless females of the summer generations of the hop aphis, *Phorodon humuli* Schrank, and also on the red spider of the hop, *Tetranychus telarius* Linn.

The species is distributed over the Pacific Coast regions, specimens having been recorded in Oregon from Vale in Eastern Oregon, and from Corvallis and Oregon City in Western Oregon. It is an important economic species in California, and is also found in the states of Washington, New Mexico, Arizona, and the province of British Columbia.

The determination of the lacewing was made for this department by Mr. Nathan Banks, of the U. S. National Museum, Washington, D. C., who originally described this species.[34]

On November 3, 1913, numerous eggs (Fig. 40 A) and larvae were found among colonies of *Aphis sorbi* Kalt., on apple trees in the experimental orchard of the College. The eggs are laid singly on the lower surface of the leaves. They may be found placed indiscriminately over the lower leaf surface, but most of them are deposited next to the midrib, lateral veins or in the axil of the two. They are laid horizontally or on end, usually the former. The egg is ovoid, white, changing to a light amber in the course of development and growth. The surface is reticulated and at one end is located a small disc-shaped structure (microyple). The duration of the egg stage is nine days.

The newly hatched larva is somewhat different from that of the mature larva, in that it is distinctly white in color, and the mouth parts are much more prominent than in the later instars. The eyes are a faint brown. It measures 2mm. in length. Upon hatching, the larva emerges from the egg at one end and remains motionless for a very short period, after which it immediately becomes very active in search of food. (Fig 40 B).

The larva molts three times, twice before spinning its cocoon and once as it transforms to the pupa. I have observed that the larvae develop much more rapidly in warm than in cold temperatures. Under the latter conditions they seem to become more sluggish and show a reluctance to feed. The larvae did not show any real disposition to cover themselves with aphis skins as is usually the case with other members of this genus. However, the skins frequently became entangled in the hairs and feet and were involuntarily carried about.

On approaching an aphis, the larva makes a quick dart for it, inserts its piercing mouth parts and sucks the blood from the victim. The duration of the larval stage and instars varies considerably according to the nature and quantity of the food supply and the rapidity with which it feeds. The larval period was found to average 14 days. The larva is somewhat spindle-shaped, tapering towards the caudal end. The head is strong and bears a pair of large sharp curved grasping and bloodsucking mandibles or jaws. The larva is amber colored with dark markings and measures about ⅓ inch in length.

When ready to pupate, the larvae as a rule seek some crevice in the bark, although cocoons were found in clustered leaves of apple curled by aphis, on the under surface of the leaves of current and hop vines. Anthracnose cankers on trunks and limbs of apple trees make desirable places for hibernation. Each larva, upon finding a suitable place, immediately begins to construcrt a very

[34]American Neuropteroid, Insects, Trans. Amer. Ent. Soc., XXIV.

thin, loosely woven cocoon. When the cocoon is constructed, it continues contracting, molts for the last time and pupates. (Fig. 40 C).

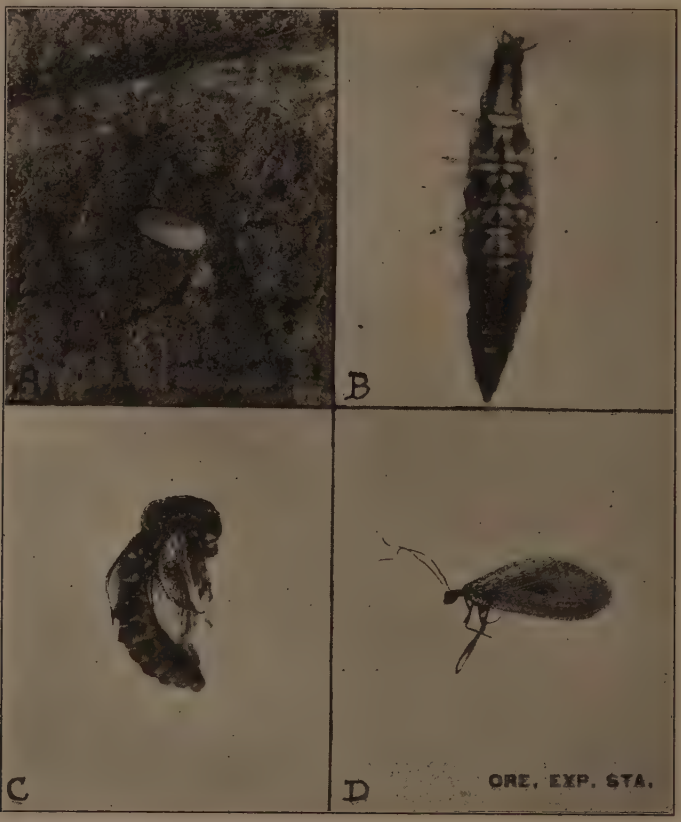


Fig. 40. The Brown Lace Wing (*Hemerobius pacificus*); a, egg; b, larva; c, pupa; d, adult

The pupa is light brown in color. It is somewhat cylindrical in shape being curved, and with the limbs and wings folded at the breast. The wing pads are at first white, changing to a light amber in color. The insect, on emerging from the cocoon, ruptures one end. The pupa apparently cuts its way out of the cocoon as the pupal skin is cast outside. The length of the pupal stage is 15 days. (Fig 40, D).

The adult is distinctly light brown in color, being lighter at first and changing gradually to a darker shade. The body is covered with short hairs. The head is small and pale in color; the eyes are prominently black. The venation of the wings is somewhat pale, marked with brown spots which are darker at the base. Rising from these spots are indistinct oblique clouds. Hind wings are white with pale veins except few outer gradate ones. Expanse of wings, $^3/_4$ to $^4/_5$ inch. When at rest, which is usually during the day, the wings are held roof-like over the body. I have observed but few on the wing

during the day, and then only when disturbed from their place of rest. Their flight is slow and sluggish.

When confined in breeding cages they do not live more than three or four days. According to some feeding data on five larvae which were fed aphids, the average total devoured for a single larva during its period as larva was 201 aphids, or 25 a day.

THE ALFALFA LOOPER AS A TRUCK CROP PEST.

Plusia Californica.

By LEROY CHILDS.

The alfalfa looper, ordinarily a distinct pest of forage and truck crops, and normally held in such complete subjection by its parasitic enemies as to be of little economic importance, has for some time been under observation in several localities where it has been found severely injuring truck crops. The damage to lettuce has been the more noticeable in Oregon the past summer. The insect's favorite food plant is, under ordinary conditions, alfalfa, and owing to this fact it has received its common name.

The injury that may be accomplished by a "worm" of this type in head lettuce is very noticeable. Observations and study of the life-history and habits were conducted at the truck garden of Mr. J. H. Koberg, of Hood River, where a three-acre patch of lettuce, valued at several hundred dollars, was in

Fig. 41. The Alfalfa Looper (*Plusia californica*); a, the moth; b, larvae feeding on lettuce; c, parasitized larva showing outline of parasites.

a few days reduced to a condition in which it was valueless. The tender leaves were not only riddled with holes, but also often consumed, by the conspicuous olive-green caterpillars. This destruction of the leaves is not the only damage accomplished. The large amount of soft excrement discharged promiscuously upon the tender foliage presents an extremely disgusting appearance, quickly rendering a vegetable of the lettuce type unfit for market.

Notes on Life-History and Habits.

Owing to the large numbers of the several parasites which usually attack the larvae of this night-flying moth, no complete life-history data have been recorded. Several workers have attempted this, but the parasites have been so effective that there has never remained sufficient material throughout a season to permit such a work. From the review of literature published on this subject, and from notes accumulated during the past summer relative to the life-history of this insect, there are apparently three complete generations a year.

Mr. J. A. Hyslop reports the appearance of the adults of the first and second broods in June and July, respectively. Continuing, he has found young larvae in the fields in late August, which he considered an incomplete third generation, and which, he believes, owing to the lateness of the season, succumbed during the winter. Our observations during the past summer and fall, however, seem to indicate that the third generation is more complete than has been supposed.

Young larvae were first observed September 25 working on lettuce planted about the middle of August. At this time a few were possibly half-grown, the larger portion being quite small. On October 7, about thirty full-grown larvae were gathered and placed in a breeding cage with a supply of food. On October 8, several of the larvae began spinning their open-meshed, white cocoons and on October 9, two were found to have pupated. The remainder of the lot were all destroyed by internal dipterous parasites, from which two specimens of *Plagia americana* Wulp. were bred. On October 26 and 27, two moths, the larvae of which pupated on October 9, emerged. The pupal period of the two individuals was 17 and 18 days, respectively.

An unsuccessful attempt was made to observe oviposition in captivity. An unmated female moth was placed in a cage with fresh lettuce heads, but no eggs were deposited. The insect was under observation a great deal of the time during its captivity, and a few notes relative to its activities were obtained.

In the five days during which it lived, natural activity began on each occasion at the same hour, or four o'clock. At no time was there a deviation of ten minutes. Vigorous intermittent fluttering occurred at short intervals throughout the evening. On the sixth day the moth appeared very weak, dying on the following day. Professor Lovett, of this department, reports the keeping of caged individuals with food in the form of syrup. In no case did the insects live longer than ten days.

Description of Stages.

Egg. The egg is pale yellow and hemispherical, the basal portion being rounded. The apex possesses a rounded depression covering a shell striated with vertical creases. It is supposed that the eggs are deposited on the foliage of the plants.

Larva. When newly hatched, the larva is a slender, light-colored creature with a prominent black head. In the course of two or three weeks' time, the skin is cast five times. After the first molt, a greenish coloration of the insect appears, which increases in depth with each successive molt, reaching a dark olive-green in the fifth stage. Constancy of coloration in all individuals is lacking, and quite often full-grown larvae will be found having a much lighter green than the usual characteristic olive-green cast.

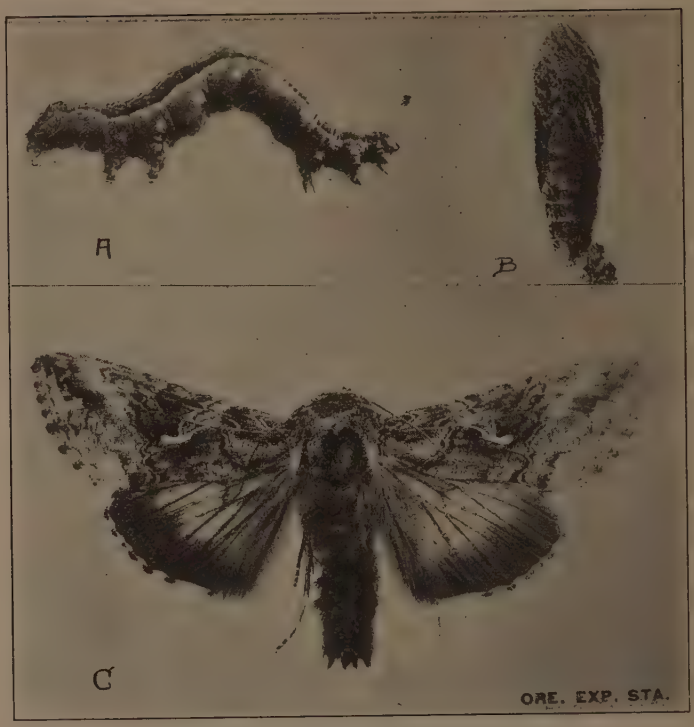


Fig. 42. The Alfalfa Looper (*Plusia californica*); a, larva; b, pupa; c, adult.

The dorsal and lateral markings of the mature larvae are extremely variable; usually a narrow, wavy, white line may be found slightly lateral to the dorsal median line of the body, and a second more conspicuous line is found on the lateral side, which blends into the lighter colored ventral surface.

The mature larvae possess three pairs of nearly black, well-developed front or thoracic legs; two pairs of abdominal legs found on the eighth and ninth segments; and a prominent posterior pair of the last abdominal segment. This arrangement of the legs and prolegs necessitates a "looping" movement, on account of which the common name "looper" has been applied. Fully mature larvae measure from 1¼ to 1½ inches in length.

Pupa. On lettuce plants, the full-grown larva moves to the under surface of an outer leaf of the lettuce head; spins there a light-meshed, white cocoon and transforms to a shining, brownish-black pupa (Fig. 42). The length of each pupa is from $^{11}/_{16}$ to ¾ inch.

Adult. The coloration is typical of the night-flying moths, being mostly gray and black, and forming a very pleasing pattern (Fig. 41). On the fore wings centrally located, is a white, hook-shaped mark much resembling the Greek letter Gamma. The basal half of the hind wings is brownish-gray, shading into brownish-black on the outer margin. This margin bears a fringe of white hair-like scales. The wing spread of a series of individuals varies between 1½ to 2 inches.

Distribution.

The alfalfa looper has been reported from nearly all of the states lying west of the Rocky Mountains. The complete local distribution in Oregon is not known. During the past season the pest was observed in considerable numbers at Hood River and Corvallis.

Host Plants.

We have observed this insect feeding on alfalfa and lettuce. Other observers report it as feeding on alfalfa, garden peas, malva, cabbage, barley, elder, and dock.

Natural Enemies.

There are seven known parasites of the larva of this insect—five hymenopterous[35] and two dipterous. Through their industrious habits, the looper pest is normally held under complete control. In the Hood River district during the past summer, the only parasites that were obtained were two species of flies. Their work is most complete. Of the looper material gathered for rearing purposes, less than 5% developed into adult insects.

Pupation of these fly parasites was observed to take place usually at the time of the death of the host, a single larva frequently containing four or five conspicuous pupal cases (Fig. 41). Usually these were located crosswise with the body of the host, through the skin of which protruded the chitenous posterior and anterior spiracle processes of the pupa of the parasite.

The exact dates upon which the pupation of these parasites took place were not obtained. Some undoubtedly passed into this stage shortly after being placed in the breeding cage, as most of the looper larvae died within a few days following their capture. On October 25, the first fly issued. The emergence of two more occurred on October 26. Other individuals continued to emerge up to November 2, when observations were discontinued.

At Corvallis, Professor Lovett obtained several hymenopterous, but no fly parasites of the looper. The destructive qualities of these little insects appear to be almost as great as those of the flies.

Control.

A number of entomological workers have attempted experiments with this pest, but the work of the parasites has been so efficient as to destroy the looper before the control became well started. With most field crops, natural control as described above is most highly satisfactory. With garden produce, especially in the case of vegetables of the lettuce type, a different problem is faced. The lettuce becomes worthless even though the attack is of very short duration.

At the present time, suggestions only can be made relative to control measures. In reviewing the literature dealing with the alfalfa looper, it is found that most authors report a very decided tendency on the part of the moths to be attracted to light, around which they accumulate in large numbers. The maintenance of trap lights possesses many disadvantages and might possibly be of little value in destroying the pest. One advantage, however, is derived from such a procedure, this being in the form of an indicator if the moths are on the wing.

The time of the insect's flight being determined, proper precautions in the form of insecticides may be directed toward the young larvae which hatch from the eggs deposited by the active moths. Arsenicals can be used with perfect safety either in the form of a dust or spray, if applied properly. To obtain efficient results, and also to destroy the insect before it has caused any appreciable damage to the crop, close watch of the garden must be maintained, and the spray applied as soon after the eggs hatch as possible.

[35] *Rhogas autographae* Vier.; *Microplitis alaskensis* Vier.; *Microplitis sp.*, *Sargaritis websteri* Vier.; *Apanteles hyslopi* Vier.

In treating lettuce, probably the best results may be obtained by dusting, the application being made with a good dust gun. The use of a mixture of arsenate of lead and finely powdered wood ashes is suggested, the formula of which is given below. The materials should be well mixed before being placed in the dusting apparatus. A light, thorough application should be made in the morning while the dew is still on the foliage. The dust is prepared as follows:

Arsenate of lead	1 pound.
Wood ashes (sifted)	20 pounds.

The following spray formula is used very satisfactorily in controlling the cabbage looper, a closely related species. It is worthy of trial should the insect become troublesome.

Arsenate of lead	1 pound.
Resin soap	3 pounds.
Water	50 gallons.

The use of the soap increases the adhesive qualities and should not be overlooked. Extreme care should naturally be employed in handling the poison. The application should not be made after the development of the head is well advanced or just before cutting time.

Too much emphasis cannot be given to the value of conducting a campaign for a thorough winter "clean up" in locations where the pest has occurred. Probably a greater portion of the insects pass the winter in the pupal stage, either upon the host plant upon which they have fed, or in close proximity. The burning or plowing under of all materials about infested fields will destroy many of the over-wintering insects. This should be done before March 1.

THE ROSE-LEAF HOPPER AS A FRUIT PEST.

Empoa rosae L.

(A Preliminary Report.)

By H. F. Wilson and Leroy Childs.

The preliminary work directed toward a complete investigation of the economic importance and biology of the rose-leaf hopper, *Empoa rosae*, brings to light many interesting features, chief of which is the finding of this insect, which normally feeds on rose, as a serious pest of apple, strawberry, and several of our cane fruits. This insect has long been known to entomologists, but has not heretofore been considered to be of great economic importance. From the brief articles contributed by entomological workers in different parts of the United States and Canada, it is quite evident that the geographic distribution of this pest is in no way limited, and that it may be found throughout a greater portion of the temperate regions of North America.

Occasional references point to the fact that the insect has been noted feeding on apple foliage—never to such an extent, however, as to warrant investiga-

Fig. 43. Apple Leaf, with Rose Leaf Hoppers at rest

tion from an economic standpoint. In the Pacific Northwest we find a very different condition; here it is an insect of primary importance as a pest of apple and strawberry, and to a less degree, of blackberry, loganberry, etc. Among ornamentals, the rose, one of the most favored plants in the Oregon garden, is often attacked by the leaf hoppers in such numbers as to cause reduced vitality, which in turn prevents the development of flowers. Where this condition exists, by a slight disturbance of the food plant, the adult insects can be "flushed" by the thousands. Except at times when they are flying about, the insects are seldom seen. When feeding and at rest, they may be found on the under surface of the leaves (Fig. 43).

Just why this insect should become a distinct pest in the Pacific Northwest and not in other localities, is a problem upon which much thought is being directed. Several factors seem to play an important part in explaining this condition, conclusive evidence of which is not sufficiently well established to permit publication at this date.

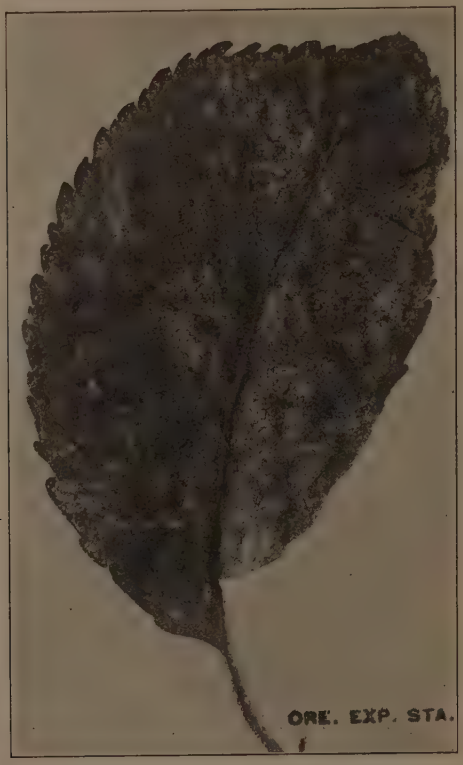


Fig. 44. Apple leaf, showing whitened areas caused by feeding punctures of the Apple Leaf Hopper.

Injury.

The nature of the injury to the food plants is of three types, two of which are confined to the foliage. The more conspicuous one and that which has a more direct effect upon the health of the plant, is caused by the insects in

sucking the juices from the leaves. As a result of this feeding, the chlorophly in the leaves is caused to be broken down, and the resulting yellow appearance of the foliage is quite noticeable. The first evidence of injury by this insect, when present only in small numbers, is an accumulation of yellowish, nearly circular spots on the under surface of the leaf.

These areas, which are about ½ to ¾ mm. in diameter (Fig. 44), are, during the early season, usually isolated from each other, giving the green leaf a mottled appearance. Later, however, as the season advances and the insects become more numerous, these circular areas overlap each other, resulting in a more or less uniform yellowing of the foliage. In several localities during the past summer, this injury was found to have advanced to such a degree as to make a large portion of the leaves functionless, causing them prematurely to drop in August.

Fig. 45. A, leaf of strawberry; b, leaf of rose showing feeding punctures on leaves.

The second injury is in the form of a folding or curling of the leaves, resembling greatly the characteristic injury of the green apple aphis. The curling of the foliage is found to be much more pronounced on the distal leaves of vigorously growing wood. From this, it would appear that young growing leaves upon which the hoppers are feeding, are stimulated so as to become malformed during their growth. Leaves nearly mature before becoming subject to attack are not malformed to a noticeable degree.

The third injury is due to the egg punctures made by the females in depositing their eggs. This injury is usually not serious except on rose bushes, where the eggs in great numbers are deposited in the stems. This results in injury to the cambium layer and a checking of the future growth of the cane. In cases where the injury is severe, the production of buds and flowers may be seriously affected.

Host Plants.

The rose is by far the most favored food plant of this species. Large numbers of adult leaf hoppers migrate from the apple in the fall to the rose.

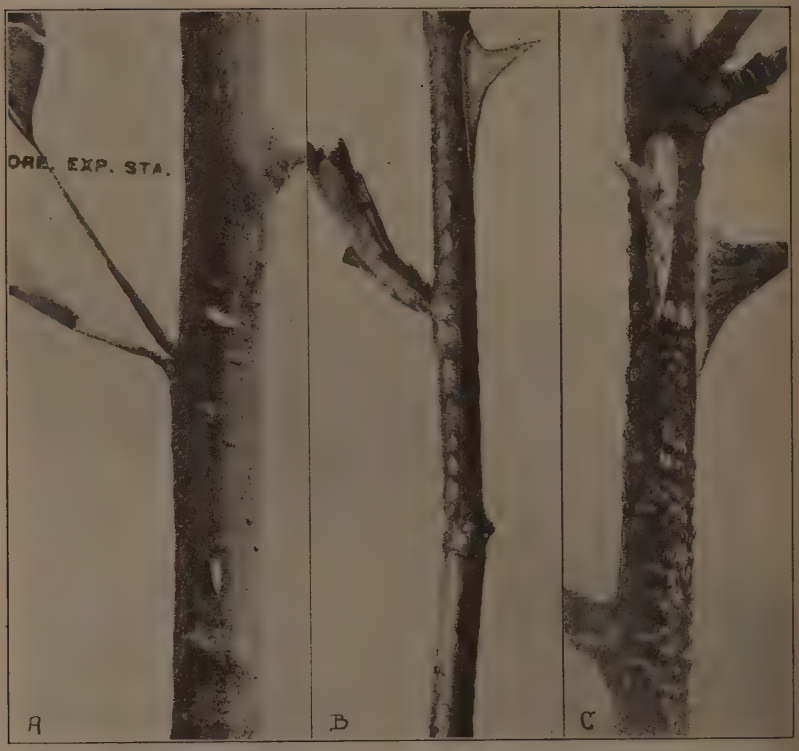


Fig. 46. Rose Leaf Hopper (*Empoa rosae*); a, twig of apple showing leaf hoppers ovipositing; b, egg punctures on rose twig; c, rose twig showing injury resulting from egg punctures.

Here the insects feed and deposit eggs until the leaves fall. Next to the rose in degree of susceptibility of attack, as shown by accumulated data, are apple, strawberry, evergreen blackberry, cultivated blackberry, loganberry, raspberry, and craetegus. Adult insects have also been found feeding on the foliage of several other trees and shrubs, including cherry, prune, elm, oak, and currant. It would appear that these plants offer temporary food for the migrating forms in the absence of something more favorable. No individuals of this insect in the nymphal stages were observed on these plants.

Life-History.

The winter is passed for the most part in the egg stage on a variety of plants, such as wild and cultivated roses, apple trees, strawberries, blackberry canes, etc. It is also likely that some of the adults live through the winter. The eggs hatch in the spring and the young nymphal forms find their way to the leaves of the various food plants and begin feeding. These nymphs reach the adult stage during June and July, and lay their eggs in the leaves of apple and possibly other plants. The adults from this generation of eggs reach maturity in the early fall and produce the over-winter eggs.

The Nymph is pale greenish-yellow in color, and in this stage cannot fly, as the wings are only partly developed. There are in all five nymphal stages.

The Adult is bright yellow to almost white in color, having two dim brown spots at the inner side of the base of the upper wings. That portion of the

Fig. 47 Egg punctures of Rose Leaf Hopper on five-year-old growth of apple.

wings which extends beyond the tip of the abdomen appears transparent. The eyes are cream colored. When disturbed, the adult flies up quickly and darts down to another resting place on the opposite side of a twig or leaf. If resting on a twig, it will usually work around the twig sidewise until it is hidden. The males are slightly smaller than the females. In copulation they rest with the tips of the abdomen together and the heads in opposite directions. There are apparently two generations each year.

The Eggs are deposited just under the outer epidermis of bark, leaf veins, strawberry runners, etc. The length of the egg stage in summer has not been determined. The eggs of the second generation last from fall until spring. They are semi-transparent in color and very soft, a fact which often makes it rather difficult to separate them from the tissue in which they are laid. They are elongate, oval in shape, being about three times as long as broad. Length, .6 to .7 mm.; width, .2 mm.

The location of the eggs can be determined by the slight to large swelling formed in the bark by the egg pockets. The way in which the egg is deposited may make a difference in the size of the swelling. Sometimes the eggs are pushed deep into the inner bark tissues, without causing a perceptible swelling. At other times they are pushed in lengthwise with the twig, and the egg outline can be seen just under the very outer layer of bark. In laying the eggs, the female usually rests with the head toward the tip of the shoot, and at that end of the swelling will be found a minute slit through which the ovipositor has been inserted. On apple twigs the eggs are usually inserted against the grain.

Natural Enemies.

There are several insect and spider enemies of the leaf hopper. From the data so far obtained on this phase of the study, it seems that a very minute hymenopterous egg-parasite plays the title role among the destroyers. Two species of spiders are found predatory upon both the nymph and adult hopper, many being ensnared in their webs, which are usually located on the under surfaces of the leaves.

The larva of a green lacewing, Chrysopa sp., probably californica, also preys upon the smaller nymphs. This insect occurs in such limited numbers, however, as to be of little importance in appreciably reducing the numbers of the leaf hoppers.

A large dragon fly was seen on several occasions "hawking" among infested apple trees. On one occasion it alighted and when caught and examined, was found to be feeding upon an adult leaf hopper.

A large scataphagid, resembling closely the common dung-fly, has been captured on several occasions feeding upon adult leaf hoppers. None of the predaceous enemies of the leaf hopper have been found in sufficient numbers to aid much in controlling the pest.

Methods of Control.

As this insect causes injury by laying eggs in the bark and feeding on the foliage of the various plants attacked, means of control should be considered for both cases. All of the eggs deposited toward the tips of the branches may be destroyed by pruning; but a great many will still remain, and, if possible, must be destroyed in some other way. It is barely possible that oil emulsions will prove efficient for this purpose.

On the foliage, kerosene and other oil emulsions may be used with considerable benefit, but tobacco sprays give much promise of being the most practical. An important factor, however, is the time and method of application. As the insects feed from the under side of the leaves, the spray must be directed toward the trees so that the under surface of the leaves will receive a thorough coating of spray.

Leaf hoppers can usually be more easily destroyed in the nymphal stage, as they cannot fly up and dodge out of the way as the adults can. Spray, therefore, while the nymphal stage is present. Use Black Leaf-40, 1 to 1,500, plus whale oil soap, one pound to each 50 gallons of water.

MINOR INSECT PESTS.

By H. F. WILSON.

THE PRIONUS BEETLE.

Prionus californicus Mots.

The orchardist notices this insect as a large, white grub, varying from one to 2½ inches in length, found feeding on the small roots and the bark of the

Fig. 48. The Prionus Beetle *Prionus californica*); a, adult; b, larva.

larger roots of fruit trees. We have noticed that they occur mostly in new ground where oak and fir stumps have not been entirely removed. Just how long it takes for them to pass through their complete life-cycle is unknown, but the grubs may be found for a number of years after the orchard is started. The adult beetle is a large brownish beetle about 1¼ to 1½ inches in length.

Nature and Extent of Injury.

The presence of this pest is usually unknown until dead trees have been taken out and the injury noticed on the roots. This usually occurs on trees from one to five years old. Around the trees at the junction and along the roots, the bark will be all eaten away; sometimes the roots will be destroyed so that the trees can be pulled out with slight effort. In digging out about the base

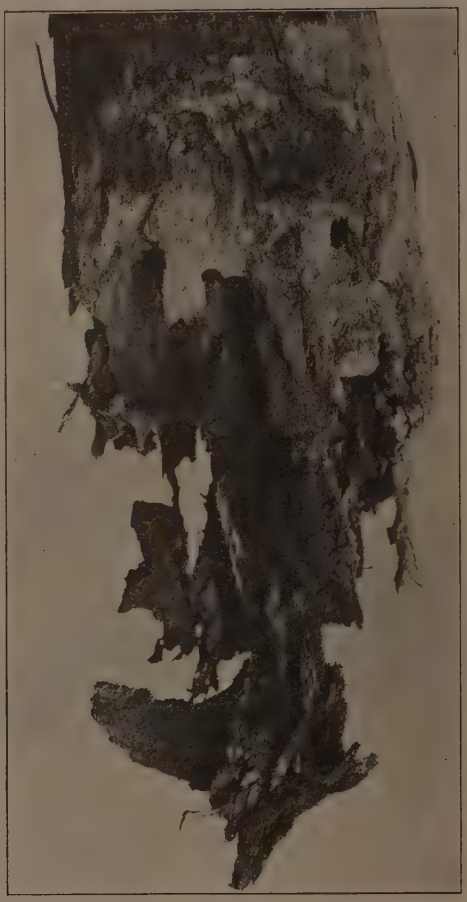


Fig. 49. Base of young dead tree showing work of Prionus Beetle.

of the tree and searching for the cause, the grower will usually find from one to half a dozen white borers.

Control Measures.

There is practically no way to reach these grubs in the ground without treating the entire orchard, at a great and, in many cases, a useless cost, for they cannot be reached except with gasses or repellants, and the latter do not seem to be effective. In cases where orchards are to be set out in land that has recently been in timber, it is suggested that hogs be pastured on such land, as they are fond of such food and will destroy all they can root out.

THE BUD WEEVILS.

Sciopthes obscurus Horn.
Paraptochus sellatus Boh.
Thricolepis inornata Horn.

These insects sometimes appear on fruit trees in immense numbers and feed on the foliage and newly opened buds. On the larger trees the damage is hardly noticeable because the comparative damage is small. Very young trees may be seriously damaged through having the head forming branches destroyed by the eating away of the buds. In the case of young scions, especially on prunes, they do considerable damage, as they will completely strip them in a short time and cause them to die. Practically nothing is known of their life-history, and so far, the adults form the only stage known. From what we have learned of closely related species, we infer that the larvae live in or on the roots of certain plants.

Fig. 50. Bud Weevil (*Thricolepis inornata*) on prune grafts; a, foliage entirely destroyed; b, beetles just starting to work.

The adult weevils are brownish beetles with ash-gray markings, and measure about $\frac{3}{16}$ to $\frac{1}{4}$ inch in length. All three species may be found alone or in company with the others, and they have a habit of playing possum when disturbed. If the branches upon which they are feeding are disturbed, they drop to the ground and lie as if dead.

Remedies.

Spraying with arsenate of lead would undoubtedly kill them, but all the weevils respond slowly to poisons, and the breeding grounds would furnish new supplies before the old disappeared, hence spraying is not a practical remedy.

The beetles have no wings, only the wing covers being prominent. This fact offers a means of control, and as the insects have to crawl into the tree, a cheap and effective preventive would be to place some sticky substance around the tree. Printer's ink would probably be the best for this, although the manufacturers of Tanglefoot are making a preparation for this use, which may prove very effective. Jar the tree in the cool of the day and the insects will fall to the ground. Then apply the sticky substance and they cannot again ascend the tree.

THE BUD CLICK BEETLE.

Limonius discoideus Lec.

Of the many minor insect pests of the Northwest, for which there appears to be no immediate ready means for control, this insect is one of the more serious. Poisons, except in extremely great strengths, are not effective quickly enough to prevent serious injury, owing to the condition of the plant at the time of the attack.

Fig. 51. Adults of the Bud Click Beetle.

Nature and Extent of Injury.

The main injury is done to young trees one to four years old, and pears seem to suffer more than others, although apples, plums, cherries, etc., are attacked to some extent. The adults are the offenders in this case, and they can be found feeding on the half-opened leaf buds in the spring. In many cases the buds are completely eaten away, and this may cause the forcing out of many buds near the tip. The final result is that the shape of the tree is unbalanced, and if continued year after year, they become badly stunted and deformed.

Life-History and Habits.

The adult is a brownish beetle commonly known as a "snapper," for the reason that when placed on its back, it flips itself into the air with a snap and turns so that it lights on its feet. It measures about $\frac{1}{2}$ to $\frac{3}{4}$ inch in length, and the body seems to be divided into two parts with the divisions near the middle.

Two years are probably required for the insect to pass through its complete life-history, and so both adult and larval stages may be found at the same time. The adults, males and females, emerge in the spring about the time the leaf buds of pears are opening, and they are quite abundant for three or four weeks. The females lay their eggs on or in the ground, and the young larvae feed on the roots of weeds and grasses. The larvae are known as wireworms and are long, slender worms, usually white to brown in color, and the body the same thickness throughout.

Control Measures.

Arsenate of lead in strengths much greater than is necessary to kill other insects seems to have no effect. Cultural methods for the destruction of the larvae in the ground in and around the orchard would seem to offer the best means of relief, as they develop in large numbers all through orchard land that is left to produce vegetation of any kind in between the trees.

THE BLOSSOM FLY.

Bibio nervosus Loew.

In the early spring when our fruit trees are in blossom, more inquiries are received relative to the economic status of this insect than for all others. Numerous indeed are the reports of serious injury being done by it, and in many cases injured blossoms or fruit accompany these reports.

In an effort to determine the amount of injury resulting from this insect, numerous observations have been made in the field, and microscopic studies of the insect and its mouth parts have been made in the laboratory. We have been unable to find a single individual causing the slightest injury, and we must, therefore, conclude, from the observations made, that the insect is beneficial rather than harmful. It is beneficial in that it works on the flowers and aids greatly in distributing pollen from one blossom to another.

In making a study of the mouth parts of this insect, we find that they are apparently made entirely for lapping or sucking. The parts are formed into a protruding part, the tip of which is composed of several soft, fleshy lobs incapable of piercing or chewing tissue of any kind.

Fig. 52. Blossom Fly; a, female; b, male.

During April and May, on account of the large numbers present, both males and females can be found flying about the blossoms, or else they may be found with the fore two-thirds of the body forced down in between the petals to the base of the flower. We believe that the insect does this in search of the nectar secreted there.

Nothing further is known of its seasonal history, except that from records of other species, we believe that the larval stages occur about the roots of grasses or other herbaceous plants. The adults, both males and females, are black in color, with brownish-red legs. The wings are smoky with black veins. In the accompanying illustration, the female is shown at A and the male at B. Fig. 52.

A PECULIAR APPLE-FEEDING INSECT.

A miner working under the skin of the apple has been observed in different parts of the United States, and specimens of this injury have been sent in to us from several sections of Western Oregon. So far as we know, this insect has never been reared, and has not been given a scientific name. We also know nothing of its habits, except that it or a similar miner appears on the canes of the raspberry, blackberry, and loganberry.

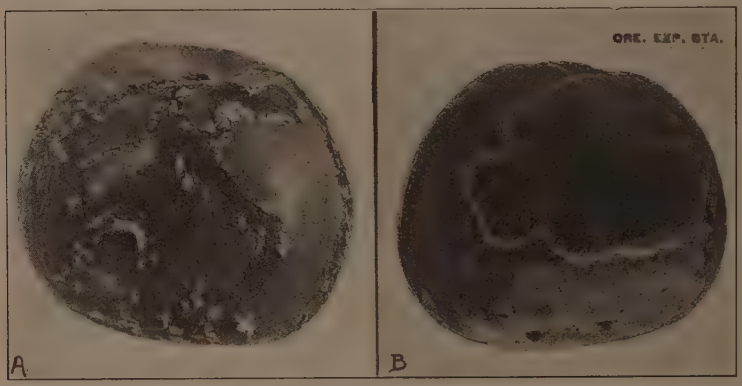


Fig. 53. Mines of Apple Miner; a, skin of apple broken away from burrow; b mine showing path of insect.

The mines are made just under the skin of the apple, and are about $\frac{1}{8}$ inch wide. They wind about in almost any direction, and sometimes the larvae will back up a short distance and start in a new direction. A dark line extends along the center of the mine, which is probably formed by the excrement thrown off by the larva. The insect is not considered to be a serious pest at this time.

THE BLACK CHERRY APHIS ON NURSERY STOCK.

Aphis cerasi Fab.

A very simple but efficient method for handling the black cherry aphis on first-season grafted or budded trees in the nursery has been determined, and it seems desirable to report it at this time. For years this insect has been doing great damage to young trees, and spraying and dipping have not proved very successful. The lice get on the newly grafted part and may cause all kinds of deformed and stunted tops.

While trying to solve the difficulty, it was noticed that the scion was fastened onto the older stock, and that the top of the old tree was cut away before the aphis hatched out. The first generation, then, come from eggs deposited on the stock below the scion. In every case a number of buds opened up below the graft, and the newly hatched aphids collected on these. The aphids were then easily removed by going along and pinching off the buds on which they had settled. I am informed by Mr. Frank Power, of the Oregon Nursery Company, that his firm has tried this method for two years now, and that it is quite successful.

TWO APPLE AND PEAR MEMBRACIDS.

Stictocephala inermis Fab.

Cerasa basalis Fab.

These two tree hoppers are quite common in the Willamette Valley and adjoining regions, but are not abundant enough to cause a great deal of damage. In all stages of nymphs and adults, the feeding occurs on the bark where the insect inserts its beak and sucks out the juices of the tree. The damage resulting from this is practically nothing, and therefore the real damage caused by insects of this kind comes not from the feeding punctures, but from the wounds made by the female insect in forming egg chambers.

Fig. 54. Egg punctures of the Apple and Pear Membracid (*Stictocephala inermis*).

In the case of these two species, we have not found the resulting injury to be serious, since the wounds heal up without leaving dead areas between the slits, as in the case of other species. At the present time we do not believe that combative measures are necessary against these insects.

THE SPOTTED DIABROTICA AS A FRUIT PEST.

Diabrotica soror Lec.

This insect has already been reported as feeding on fruit trees, which would indicate that there is a good chance for it to become a serious fruit pest, as well as a pest of garden and field crops. In this State, important damage has been done to peaches and prunes, and it is reported as feeding on the leaves of young almond and apple trees. The damage to the fruit is caused by the numerous feeding burrows made by the beetles (See Fig. 48). Should this

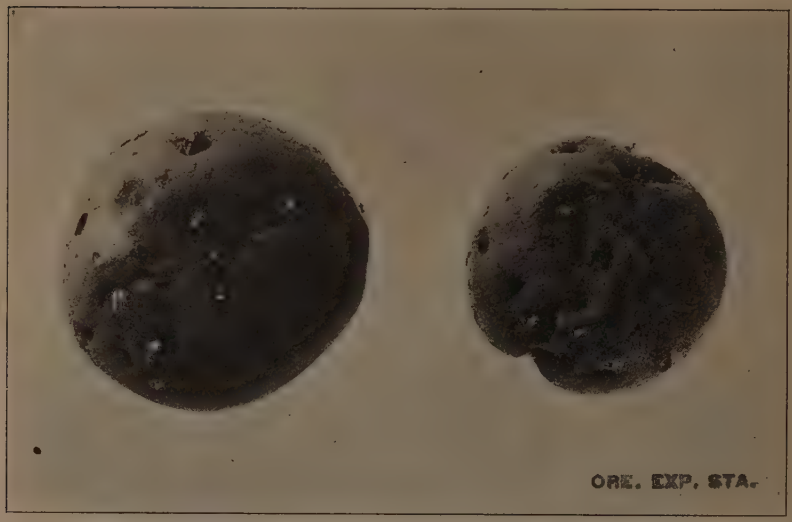


Fig. 55. The Spotted Diabrotica working on peaches.

insect be present in great numbers, some idea of the resulting damage may be gained from the figure indicated.

The Colorado potato beetle, *Leptinotarsa decemlineata* Say., was found in Union County, near La Grande, Oregon, the past summer. Prompt action on the part of the County Agriculturist, C. C. Cate, with the hearty co-operation of local men, has very probably stamped out the outbreak at the initial point of infestation.—A. L. Lovett.

The large leaf hopper, *Gypona octolineata*, was fairly numerous in the College loganberry field during July. The injury was too scattered to be marked.—A. L. Lovett.

Specimens of the drug store beetle, *Sitodrepa panicea* Linn., were received from Salem, Oregon. They were taken from a can of poison wheat prepared for gophers. This can had not been opened for two or three years. The beetles were in fine condition and had evidently thrived on the poisoned bait.—A. L. Lovett.

PART III.

Report

OF

Department of Botany and Plant Pathology

INTRODUCTION.

The present report for the department of Botany and Plant Pathology includes seven articles, as follows:

A Pacific Coast rust attacking pear, quince, etc., by H. S. Jackson.

A new filbert disease in Oregon, by H. P. Barss.

Bacterial gummosis or bacterial canker of cherries—a progress report, by H. P. Barss.

Experimental spraying of prunes for control of brown rot, by F. D. Bailey.

Notes on miscellaneous potato diseases, by F. D. Bailey.

Potato spraying experiments, by F. D. Bailey.

Notes, observations, and minor investigations of plant diseases, by H. S. Jackson.

As announced in the biennial report for 1911-1912, the Department of Botany and Plant Pathology is conducting various investigations, including winter injury of fruit trees, together with associated canker diseases, apple fruit rots and spots, mushroom root rot of fruit trees, etc. Observations are being continued on these troubles, but results do not warrant publication at the present time. An investigation of certain of these diseases is now being centered largely at the Hood River Experiment Station.

Investigations will be continued in the future on several of the diseases on which preliminary reports are being made at this time. Special attention will continue to be given to investigation of potato diseases, and more active work will be taken up on apple and pear canker diseases, several of which seem to be of importance.—H. S. J.

A PACIFIC COAST RUST ATTACKING PEAR, QUINCE, ETC.[1]

By H. S. JACKSON.

Diseases due to rust fungi have long been known, in various parts of the world, to attack members of the apple family. Several species are known in Europe and a larger number are known to occur in America. Perhaps the best known form is the one causing the common apple rust in the eastern and middle western states.

Rusts in General.

The rusts are all parasitic fungi. The vegetative stage, or mycelium, lives in the tissues of the host and absorbs from the tissues of the host the nutriment necessary for the development of the fungus. The spores or reproductive bodies are borne in more or less definite groups or sori, which develop usually just beneath the outer layer of cells (epidermis) of the host, and later become ruptured, exposing the spores; or the spores are set free by the disintegration of the tissues after the normal death of the leaves or parts affected.

These fungi are especially remarkable because many forms have in their life-history from two to five different spore-bearing stages, very unlike each other in general appearance as well as in microscopic character; and because in many species the different stages require for their full development two totally different host plants.

In the case of the common apple rust mentioned above, for example, the alternate host is the Eastern Red Cedar, *Juniperus virginiana*. Early in the spring on the twigs of the cedar, spore-bearing structures known as "cedar apples" are developed. This stage is known as the III or telial stage, and the spores, known as teliospores, are mature in the early spring about the time the apple trees come into leaf. These spores are not disseminated, but germinate while still attached to the trees. On germination they produce secondary spores, known as sporidia, which are disseminated by the wind and are carried to the apple where they germinate on the foliage, resulting in the "apple rust". This stage is commonly spoken of as the I or aecial stage and has no resemblance to the III or telial stage on the cedar. There is no II or uredinial stage in the life-history of these rusts, as is common on the grass or grain rusts. The aecial stage is often referred to as the "cluster-cup" stage, and the spores developed therein are in turn carried by the wind to the cedar leaves where they germinate and cause infection resulting ultimately in the development of the telia-bearing "cedar apples" in the spring. In the eastern rust, discussed above, two years are required for the development of the teliospores after infection by the aeciospores.

Rust on Pears.

An aecial rust on the cultivated pear has been known in Oregon for a number of years. It seems to have first attracted attention in 1907, when specimens were received from a number of different localities. Since that time it has been sent in occasionally by correspondents, and was particularly abundant during the spring and summer of 1913. The first record that the writer has been able to obtain of the occurrence of this disease on pear in Oregon is found in the correspondence files of the Oregon Experiment Station, which show that specimens of a rust, presumably the one under discussion, were sent in from Roseburg in Douglas County, Medford in Jackson County, Lebanon in Linn County, and Creswell in Lane County in May, 1907.

Unfortunately these specimens were not preserved; but from conversation with Professor A. B. Cordley, who carried on the correspondence at that time, it seems quite certain that the specimens referred to are of the same species as the one the writer has since observed. The same disease was reported

[1]This paper is essentially the same as an article by the same author which appeared in Phytopathology 4; 262–269, Aug., 1914. See also (6). Numbers in parentheses refer to bibliography, page 212

Fig. 1. Cluster cup stage of cedar rust on various economic hosts; (1) on fruit of quince; (2) on twig of quince; (3) on leaf of quince; (4) on leaf of flowering crab; (5) on fruit of pear; (6) on fruit of Japanese quince; (7) on leaves of pear (the result of infection in the greenhouse). Reprint from Phytopathology, Vol. 4.

again, once during the spring of 1911 from Star, Lane County, and frequently from various localities during May and June, 1912.

A search of the literature revealed the fact that no rust answering the description of the one under discussion had ever been recorded as occurring on any host of economic importance belonging to the apple family (*Pomaceae*).[2]

It was found, however, that an aecial rust (*Aecidium blasdaleanum* Dietel & Holway) was known to attack the native hawthorn (*Crataegus douglasii*) and the native service berry (*Amelanchier florida*), which agreed exactly in gross morphological as well as microscopic characters with the one on pear. This form of the native host has been shown by Dr. J. C. Arthur,[2-3] of Purdue University, to be connected in its life-history with a telial rust (*Gymnosporangium blasdaleanum* (D. & H., Kern) on the incense cedar (*Libocedrus decurrens*), which occurs commonly throughout certain sections of this state as well as California. No evidence was at hand, however, except the morphological resemblance, to indicate that the form on the native and cultivated hosts was identical.

On this account, the writer became interested in the study of the rust, with the hope that the exact status of the species could be established, both as to its relation with the one occurring on the native pomaceous hosts, as well as any possible relationship to the form on the incense cedar. The writer first saw the rust under discussion on the pear in the field in the spring of 1912 at Riddle, Douglas County, Oregon. A serious outbreak was reported by a correspondent, and the writer visited the locality to investigate the possibility of the relation of this form with the one occurring on the native pomaceous host and the local cedar rust. It was interesting to note that fully 50% of the fruit of one pear tree (the only one occurring in the particular locality) was affected by this disease. Not more than 200 feet away was a grove of incense cedar with the rust (*Gymnosporangium blasdaleanum*) occurring abundantly on the leaves. In the immediate vicinity was found a rust upon the leaves and fruit of the native hawthorn, which agreed in morphological characters with the one on the pear.

Since that time the writer has examined specimens of this disease on the fruit of pear from all the counties mentioned above—namely, Douglas, Jackson, Linn and Lane. Usually cedars affected with the characteristic telial rust were found in the immediate vicinity. At Halsey, in Lane County, however, where the disease was abundant in 1913, affected trees were not found in the immediate vicinity, but were known to occur in the hills at a distance of about seven or eight miles, with a level country intervening.

Reports during 1913 indicated that the disease was not uncommon in the Willamette Valley from Eugene to Albany and eastward to the foothills of the Cascade Mountains. Yet the cedar occurs naturally in the valley only a short distance north of Eugene along the Willamette River. Cedars are occasionally planted, but these as a rule have not been found to be affected. All of the region mentioned, however, was within eight or ten miles of the foothills, where the incense cedar occurs naturally.

[2]This fungus is particularly interesting since it proves to be a true Aecidium and in this respect differs from all other aecial rusts occurring upon the cultivated pear, apple, or quince. All others are of the *Roestelia* type and all are known to be connected with various species of *Gymnosporangium*.

An examination of the literature shows that there are only three species of true *Aecidium* recognized by mycologists which occur on Pomaceous hosts. They are as follows:

Aecidium Blasdaleanum Dietel & Holway. (4)

This species was originally described from northern California on *Crataegus rivularis* Nutt. and *Amelanchier alnifolia* Nutt., and has since been reported by Kern (10 - 11) as occurring on the latter host and *Amelanchier florida* Lindl. from Oregon and on *Amelanchier pallida* Greene from California and *Crataegus Douglasii* Lindl. from both northern California and Oregon.

Aecidium Sorbi Arth. (1).

Originally recorded on *Sorbus occidentalis* (S. Wats.) Greene from British Columbia, and since reported by Kern (10 - 11) as occurring upon the above host from Washington, on *Malus rivularis* (Doug.) Roem. from British Columbia and on *Sorbus Scopulina* Greene from Alaska.

Aecidium Pourthiaeae Sydow. (17)

Recorded on *Pourthiaea villosa* (Thumb.) Dec. from Japan.

Rust on Quince.

In July, 1912, specimens of quince fruit affected with a similar aecial rust were sent in from Eugene, Oregon, with a statement that half of the fruit on the trees showed infection. These specimens showed a remarkable distortion. The writer personally visited this locality and found the disease not only on the fruit, affecting fully 50 per cent, but also very abundantly on the leaves, where the spots were usually small. Occasionally the twigs were attacked, causing enlargement and distortion. Incense cedars affected with the telial rust were found in the vicinity. The disease on quince was again observed in the season of 1913 at Halsey, Oregon, and was sent in by correspondents from Creswell and Eugene.

Rust on Other Hosts.

Since this disease is found so commonly on the pear and quince, it occurred to the writer that other hosts might be affected. A search was made, therefore, for the aecial form on apple, but this was never personally collected by the writer. A specimen on the leaf of a Jonathan apple, however, was sent in by Mr. Stewart, of Cottage Grove, who has taken a great deal of interest in aiding the writer in making observations on this trouble. A specimen on the fruit of Winter Banana apple was sent in by Mr. J. O. Holt, of Eugene. Other observers have reported the occurrence on apples. Specimens have also been collected on two cultivated species of mountain ash at Cottage Grove, first by Mr. C. E. Stewart and later by the writer. On these hosts the fruit only was affected. These hosts were provisionally determined to be *Sorbus sambucifolia* and *Sorbus spuria*. In June, 1914, Mr. G. H. Godfrey collected at Eugene the same rust on the fruit of *Cydonia japonica*, the Japanese quince.

In the vicinity of Cottage Grove the disease was also found abundant on the fruit and foliage of the native Oregon crab, *Malus rivularis*. This host is known to hybridize commonly with the cultivated apple. Such hybrids were found commonly affected both on foliage and fruit. In addition to the above-mentioned host, the disease was found on young fruit of a flowering crab, the exact species of which was not determined, but it is apparently the plant distributed by Western nurserymen under the name *Malus floribundus*. The disease was also found at Cottage Grove on the foliage of what was apparently the same species not yet of sufficient age to blossom.

The writer has carefully examined specimens of this rust on all of these hosts and all agree in every respect with the form which occurs on the native hawthorn and service berry. It is important to note that wherever this form has been found on cultivated pomaceous hosts, the same form is found locally abundant on native hosts. This rust has never been collected either on native or cultivated hosts except within a reasonable range of the incense cedar, which is always in such cases found to be affected with the characteristic telial stage.

Description of the Aecial Rust.

The rust as it occurs on its various hosts exhibits a great deal of variation, particularly in the size of the spots found. The spots are, in general, yellow or orange, and when mature are seen to consist of few to many cuplike structures, just large enough to be seen with the naked eye. These are the aecia. The spores are borne in chains inside the aecia and are produced in great numbers. Examination with a hand lens shows that the cups are surrounded by a white margin which in the early stages of development forms a closed structure about the developing spores. These are developed beneath the epidermis of the host and finally burst open, exposing the spores. This surrounding structure is the peridium and when fully opened is seen to have a delicately lacerate margin which is spreading or somewhat recurved.

The spots vary greatly in size, as reference to the plates will show. On the quince sometimes half the fruit is involved, causing great distortion and hundreds of aecia may be developed on the deformed area. Often the stems

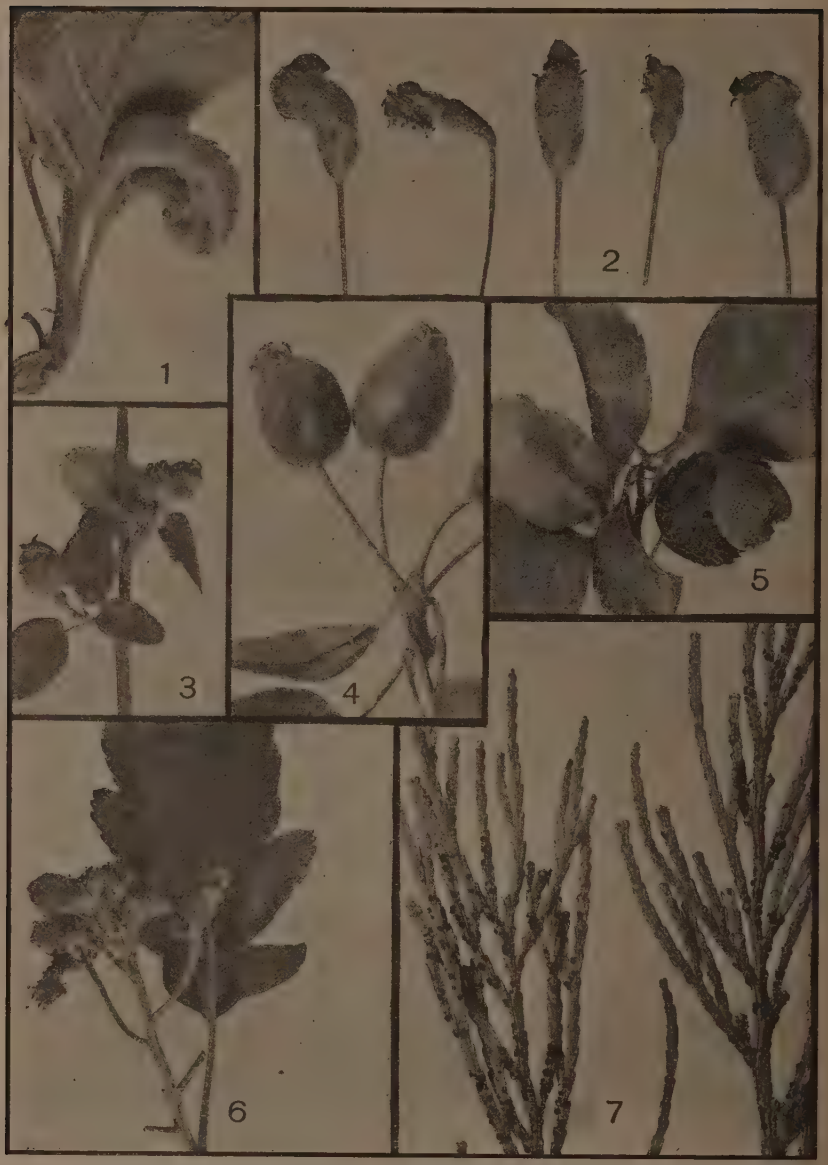


Fig. 2. Cedar rust on various hosts; (1) on leaf of Jonathan apple; (2) on fruit of flowering crab; (3) on fruit of native service berry; (4) on fruit of hybrid between native crab and cultivated apple; (5) on fruit of native hawthorne; (6) on fruit of hybrid mountain ash; (7) telial stage on leaves of incense cedar. Reprint from Phytopathology, Vol. 4.

are affected for considerable distances, resulting frequently in distortion for one to two inches in extent. This is quite common on the quince, hawthorn, and service berry. On the two latter hosts the entire fruit is often distorted. This is also true of the native crab. On the leaves, the infection may cover considerable areas, but more frequently the spots are small, sometimes only two or three aecia being found in the spots. On the leaves, moreover, they are only found on the under surface.

Inoculation Experiments.

In the spring of 1913 an attempt was made in the laboratory to inoculate pear, apple, and quince by using spores from the rust on the incense cedar, but without success. The writer now recognizes that the conditions were not ideal for infection and no importance is to be placed on these negative results.

Early in February, 1914, potted trees of pear, quince, and apple were removed to the greenhouse and when well started into growth, an attempt at infection with spores from the cedar was again made. The first experiment was set up February 20, but the spores from the cedar were immature and no infection resulted. On March 21 another set of experiments was started, using the following method: A platform was built so that a large bell jar could be set over the top of each tree which it was desired to infect. Branches of cedar collected by the writer in Eugene containing abundant ripe spores were placed under the bell jars and so arranged that the secondary spores developing on the germination of the teliospores would fall on the unfolding leaves. The foliage of the cedar, as well as the tree to be infected, was thoroughly moistened at the beginning of the experiment. Bell jars were kept over the trees for three successive days and nights, being removed every day for a few moments, the inside of the jars moistened and the foliage sprinkled. During the experiment the trees were kept shaded from the direct rays of the sun. One quince and two pear trees of the Bartlett variety were used in this experiment. All became abundantly infected, showing the first signs of infection about April 10, with fully developed cluster cups on April 18.

The experiment was repeated in the greenhouse beginning March 30, using material from the cedar sent from Cottage Grove. Two pear trees and one apple were used. Both pear trees became abundantly infected, resulting in mature aecia about April 30. Infection started abundantly on the apple, but in no cases did the aecia mature. Small black spots finally resulted.

The rust under consideration has never been found naturally in Benton County, in which Corvallis is located, although the writer has made repeated and very careful search for it on such cultivated trees of incense cedar as occur in this locality, and for the corresponding stage on the various pomaceous hosts, both native and cultivated. On this account it was considered that field infection experiments would be fully as conclusive as those in the greenhouse. Consequently on March 21, infected cedar branches from Eugene were placed in tin cans containing water and hung among the branches of three pear and three quince trees in the College orchard. Fortunately, weather conditions excellent for infection prevailed for some time after the experiment was arranged, and in all cases abundant infection resulted on the quinces and scattered infection on the pears. Mature aecia were collected May 12.

On the same date (March 21) cedar branches from the same source as those used in the experiment outlined above were hung in a tree of native service berry which was in blossom, and also in a tree of native hawthorn. On March 30 branches were hung in another tree of native hawthorn and in a tree of the native crab apple. These trees were visited on May 12 and abundant infection with mature aecia was found on the service berry, with particularly abundant infection upon the young developing fruit. Quite abundant infection was found on the foliage of both hawthorn trees and scattered infection upon the foliage of the native crab.

In connection with all the experiments where infection was obtained on trees out of doors, whether cultivated or native, it was found that infection

Fig. 3. Small witches broom on incense cedar caused the rust (Gymnosporangium blasdaleanum). Reprint from Phytopathology, Vol. 4.

occurred only in the immediate vicinity of the cedar branches. In the case of the quince trees, moreover, infection occurred only on the side of the trees where branches were hung, with one exception, in which a fruit on the opposite side of the tree was later found to be infected. The abundance of infection in all cases decreased with the distance from the infected material. Other trees in which cedar branches were not placed, but which occurred in the immediate vicinity of those used in the experiment, were carefully examined but in no case was infection found.

In all experiments, both in the greenhouse and in the field, the rust resulting was typical of *Aecidium blasdaleanum*.

Based upon the results of these cultural experiments and upon the morphological characters of the rust, the writer believes that the form studied on all the hosts mentioned is the aecial or cluster cup stage of *Gymnosporangium blasdaleanum*. Following is a list of the hosts upon which this has been found by the writer in Oregon:

Pyrus communis L., Cultivated Pear.

Cydonia vulgaris L., Cultivated Quince.
Cydonia Japonica Pers., Japanese Quince.
Malus malus (L.) Britton, Cultivated Apple.
Malus rivularis (Doug.) Roem., Native Crab Apple.
Malus rivularis X Malus malus, Natural hybrid.
Malus floribundus Siebold, Flowering Crab.
Sorbus spuria Pers., Hybrid Mountain Ash.
Sorbus sambucifolia Roem., Cultivated Mountain Ash.
Crataegus Douglasii Lindl., Native Hawthorn.
Amelanchier alnifolia Roem., Native Service Berry.

Perennial Nature of Rust on Cedar.

The telial stage of the rust occurring on the incense cedar has been commonly considered to develop from an annual mycelium. While making observations on affected cedar trees in connection with these studies, however, the writer found that abnormal clusters of branches known as "witches' brooms" were very abundant. In fact, they were always observed to occur on old trees affected with the rust. An examination being made of many of these, the leaves were always found to be abundantly covered with the characteristic pustules of *Gymnosporangium blasdaleanum*. An examination of the tissues showed mycelium to be always present. These observations supplement those of Meinecke.[12]

In the older parts of the "witches' broom" the mycelium is most abundant in the pith. "Witches' brooms" were found in all stages of development and always covered with the rust. These brooms may reach a large size, sometimes two feet in diameter.

In certain of the above-described infection experiments, cedar branches with the "witches' brooms" were used in comparison with infected, but otherwise normal, branches. In all cases infection occurred equally well and no difference could be observed in the resulting aecia, indicating that the rust found upon the "witches' brooms" is the same as that found upon the normal branches of cedar.

SUGGESTIONS FOR CONTROL.

No experiments for the control of this rust have as yet been conducted. It was observed at Cottage Grove, however, that trees sprayed with 1-30 lime-sulfur solution for the pear scab just before blossoming were less seriously affected than unsprayed trees. It is probable that, should a single application at this time fail, on future experience, to control the trouble satisfactorily, an additional spray one week or ten days previous to the first scab spray, as commonly applied in Oregon, would doubtless aid in reducing the infection. Bordeaux mixture, 5-5-50, is to be recommended in place of lime sulfur on account of its greater fungicidal value.

As in all rusts of this nature, the two host plants are necessary in order that the full life-history of the rust may be completed. On this account the rust upon the pomaceous host will never be found except within a reasonable distance of infected cedar trees. Since the rust on the cedar is often perennial, it is possible for cedar trees to retain infection year after year without becoming infected anew from the pomaceous hosts. On this account, wherever it is practicable, it is probable that the rust on the pomaceous host could be greatly reduced by cutting out all unnecessary cedar trees in the immediate vicinity. That is, if trouble is experienced with this rust, all trees of incense cedar planted for ornament should be removed, and where possible all trees in fence rows or along county roads and in woodlots close to orchards should be cut out. As noted above, the rust is apparently capable of spreading by the wind to the pear and other pomaceous hosts, for long distances, and since the incense cedar is a valuable forest tree, it will probably not be practical in all cases to control the rust by this method. In such cases, it is probable that spraying, as outlined above, will need to be carried out.

BIBLIOGRAPHY.

1. ARTHUR, J. C. New species of Uredineae V. Bull. Torrey Club **33:** 521. 1906. Describes Aecidium sorbi.
2. ARTHUR, J. C. Culture of Uredineae in 1908. Mycologia **1:** 252. 1909. Shows Gymnosporangium libocedri (P. Henn.) Kern to be genetically connected with Aecidium blasdaleanum, D. & H.
3. ARTHUR, J. C. Cultures of Uredineae in 1911. Mycologia **4:** 57. 1912. Records results of culture work supplementing the work of 1908.
4. DIETEL, P. New North American Uredineae. Erythea **3:** 77. 1895. Contains original description of Aecidium blasdaleanum D. & H.
5. HENNINGS, P. Fungi Americana Borealis. Hedwigia **37:** 271. 1898. Describes Phragmidium libocedri. Considers this to be the same as that mentioned by Mahr as Gymnosporangium libocedri (nomen nudum).
6. JACKSON, H. S. A New Rust of Economic Importance Occurring on Pomaceous Hosts. Phytopathology **4:** 41. 1914. Abstract of paper read before American Phytopathological Society. Cleveland meeting, Dec. 30, 1913–Jan. 2, 1914.
7. JACKSON, H. S. A New Pomaceous Rust of Economic Importance. Gymnosporangium blasdaleanum. Phytopathology **4:** 261–269, 2 pl. 1 text fig. Aug., 1914.
8. KERN, F. D. Studies in the Genus Gymnosporangium. Bull. Torrey Bot. Club **35:** 509. 1908. Used a new combination G. libocedri (Henn.) Kern; considers G. aurantiacum Sydow. to be a synonym.
9. KERN, F. D. Prediction of relationships among some parasitic fungi. Science N. S. **31:** 830–833. May 27, 1910. Suggest that Uredo nootkatensis Trelease will sometime be proven to be genetically connected with Aecidium sorbi. Also suggsts the possibility of a uredinial form being found in the life history of Gymnosporangium blasdaleanum.
10. KERN, F. D. A biologic and taxonomic study of the genus Gymnosporangium. Bull. N. Y. Bot. Gard. **7:** 437. 1911. First use of combinations Gymnosporangium blasdaleanum (Dietel & Holway) Kern and G. sorbi (Arthur) Kern.
11. KERN, F. D. North American Flora. **7,** Part 3. 190. 1912.
12. MAHR, H. Die Waldungen von Nordamerika. 1890. Used name Gymnosporangium libocedri for rust on Libocedrus decurrens, but did not describe the fungus in such a way as to establish the name.
13. MEINECKE, E. P. Forest Tree Diseases Common in California and Nevada. U. S. Dept. Agr., Forest Service, Feb. 14, 1914. Describes "witches' brooms" caused by Gymnosporangium blasdaleanum.
14. O'GARA, P. J. A rust—new on apples, pears and other pome fruits. Science **39:** 620–621. Apr. 24, 1914. Includes record of independent observations on occurrence of this disease in Oregon.
15. SACCARDO, P. A., PECK, C. H., TRELEASE, WM. The Fungi of Alaska. Harriman Alaska Exp. **5:** 36. 1904. Describes Uredo nootkatensis Trelease.
16. SYDOW, H. u. P. Mem. Herb. Boiss. **4:** 3. 1900. Describes Aecidium pourthiaeae.
17. SYDOW, H. u. P. Neue und kritische Uredineen. Ann. Myc. **2:** 28. 1904. In this paper Sydow expresses the opinion that Phragmidium libocedri refers to the same form as Gymnosporangium libocedri Mahr. He, however, considered material which he had received from California as distinct and describes it as Gymnosporangium aurantiacum Sydow. (Preoccupied.)

A NEW FILBERT DISEASE IN OREGON.

A Preliminary Report.

By H. P. Barss.

At the present time there are comparatively few filbert plantings in the State of Oregon, and most of these are still rather young. From present indications, however, it would appear that the climate of Western Oregon is favorable to the development of the trees, and, at the same time, the yield of nuts in some of our well-cared-for orchards is such as to encourage further plantings. There seems to be no reason why filbert growing should not develop into a profitable industry of considerable proportions. On this account, we wish to call attention to the prevalence in Oregon of a new filbert disease which, up to the present time, does not seem to have been reported either in this country or elsewhere.

This disease is apparently not confined to only a few orchards or localities in the State, but seems to be distributed quite widely, at least in the Willamette Valley region. Where susceptible varieties of filberts have been grown, the loss caused by the trouble has often been very severe. Certain varieties, however, seem to be almost or totally immune from the disease, and even among those that are attacked some appear to be much more resistant than others. These facts have led the department of Botany and Plant Pathology of this institution to enter into an investigation of the disease. This report presents a brief discussion of the preliminary observations and experiments that have been conducted thus far. The work is to be continued and further report will be made.

Records of Occurrence and Results of Isolation Cultures.

The earliest record which this department has of any filbert disease whatever is dated August 23, 1909. At that time specimens of immature green nuts bearing on the surface dark spots from which, in some cases, drops of a brownish juice were oozing, were sent to the College from Shaw, Oregon. The interior of these nuts contained a dark, spongy mass with many large air-spaces in place of the normal meat of the nut. This condition was reported again in 1912. Specimens were sent to us also in 1913 and 1914 and various growers have stated that it is a common trouble in certain seasons. Microscopic examination and cultures from such specimens, at different times, have given no evidence of the existence of any internal parasite as the cause of the trouble, nor has any connection been proved between this discoloration of the outside and degeneration of the inside of the nut with the disease described in the following pages, although such connection may exist.

On July 11, 1913, filbert twigs of the DuChilly and Barcelona varieties were sent in from Woodburn, Oregon, presenting typical cases of our disease. These specimens showed peculiar dead areas of bark girdling the twigs, the outer ends of which had died as a result. The owner of the planting stated in a letter that this trouble had been noticed also during the two preceding years. Microscopic examination showed that in every instance the affected bark contained spaces that were filled with masses of countless bacteria. Cultures were accordingly prepared, and a pure growth of numerous bacterial colonies of a distinctive type appeared in the dilution platings made from the inner tissues of such bark. On August 4 of the same year, specimens of affected filbert twigs were received from Aurora, Oregon. Myriads of bacteria were found also in the dead bark of these specimens. Late in the autumn, the writer went through the filbert planting in the College orchard at Corvallis, and found there branch cankers and numerous dead twigs on many of the varieties. Microscopic examination showed the same bacterial masses in the bark as in previous cases, and cultures made from six different twigs not all of the same variety showed the presence of an organism apparently identical with the one found before.

On December 24, specimens of the same disease were collected from different varieties of filbert in a six-year-old planting near Wilsonville, cultures from which yielded bacteria of the same type as before. In January, 1914, specimens of branch and trunk cankers from Woodburn were examined, and cultures made

with precisely the same results. This was also the case with cultures made from affected filbert twigs collected at Springfield, Oregon, at about the same time. In February specimens collected from Dundee, Oregon, showed the typical diseased appearance, and cultures gave apparently the same organism as in all the other cases. The work of the summer, fall, and winter with branch cankers thus gave uniform results.

Fig. 4. The base of the new shoot at the left shows bacterial slime oozing from the diseased tissues under moist atmospheric conditions. May, 1914. 2 diams.

On April 4, 1914, specimens of filbert twigs showing blighted buds were brought in from the College planting at Corvallis. These dead buds were found to contain masses of bacteria and dilution cultures from one of them gave an almost pure culture of the typical bacteria previously secured from cankers. Here was a new phase of our trouble. By May 23 the shoots and new leaves of the filberts were well out, and on this date when one of the orchards in which the disease had previously been found was visited, an interesting condition was discovered. Many of the tender young shoots were blighted at the tips, or showed the presence of recently developed cankers. In many of these instances slimy masses of bacteria were oozing out to the surface and collecting in drops. See Fig. 4. The appearance of the ooze was exactly like that of the growth on artificial culture media made by the filbert bacteria previously secured. The weather on the day of the observation was misty, with a slight drizzle, sufficient to wash this bacterial ooze down along the twigs, or cause it to drip onto leaves or shoots below. That leaf infection might result from the dripping of bacteria seemed entirely possible, and it required no long search to find leaves that were sprinkled over with tiny, dark, irregular spots, or showing dead areas of larger size. Later microscopic examination showed that wherever these speckles and spots were found, the leaf tissue was filled with bacteria. In culture, these bacteria were exactly like those previously isolated. The ooze from the twigs also yielded similar cultures. In June specimens of blighted twigs were collected near Gresham, Oregon, and cultures showed the same type of organisms. During this month and the following, cultures were also made from speckled leaves, blighted shoots, diseased branches and a cankered trunk, from various sources, and what appeared to be identically the same bacteria came up in all cases.

Summary. To summarize the above, thirty-seven attempts were made to isolate a parasitic organism from specimens of diseased trunks, branches, twigs, leaves, and buds from six different localities. In thirty-four cases the cultures showed apparently the same distinctive organism, usually predominating, and in many instances pure. The only exceptions were isolations attempted from two blighted buds in the spring, and from one limb canker in the middle of the winter, none of which yielded this organism. Naturally, these bacteria were suspected of causing the disease, and attempts were made to prove the truth of this supposition by artificial inoculations.

Inoculation Experiments.

Three young filbert trees at Corvallis (all that could be secured for this purpose at the time) were inoculated with pure cultures by needle punctures

on the last of December, 1913, and the first of January, 1914, but no results appeared from the inoculations. Filbert cuttings were secured and planted out in the spring, but delay in securing a patch of ground for the purpose resulted in planting so late that inoculations could not be made until dry weather, which is unfavorable to the disease, had come on. Although an extensive series was made, no conclusive results were obtained. Toward the end of June, and again at the end of July, numerous inoculations were attempted on rooted filbert cuttings that had been transplanted to pots in the greenhouse. As a result of the transplanting the normal development of the cuttings was retarded and the rapid growth and succulence of the new shoots, which are apparently necessary for the greatest activity of the disease in nature, were greatly diminished. As a consequence of these conditions, inoculations made in various ways gave only slight and inconclusive results, although in several instances apparently positive infections were secured. So meager were such instances, however, in comparison with the total number of inoculations, that sound judgment would not place much weight upon such evidence. In view of the circumstances, however, under which the inoculations of this season were made, it would be equally unreasonable to conclude that the bacteria with which the attempted inoculations were made are not disease-producing organisms. Preparations are being made for a more extensive series of tests during the coming spring under conditions which will be much more satisfactory than those of last year. It is expected that these tests will give more definite evidence as to the relation of this organism to the disease. Studies in regard to the identity and nature of the bacteria are also now in progress.

Description of the Disease and Its Life-History.

Dissemination. From careful observation of the evidence presented, it seems probable that the disease may be carried over from one season to the other in what may be called hold-over cankers, and also in infected buds. Isolations of living bacteria were made from cankers during November, December, January, and February. In early April living bacteria were found in a bud

Fig. 5. Tips of new shoots blighted off by the disease. In the specimen at the left a new shoot has been forced out from the axil of the uppermost healthy leaf. Natural size.

Fig. 7. Branch showing a typical girdled and broken-down shoot at the left. The disease has spread to and girdled the main axis, although no effect is yet evident in the foliage.

Fig. 6. Branch showing the independent blighting of every new shoot before the main axis became affected.

that was dead at the time the bushes came out in the spring. From such sources as these the bacteria may easily be carried to the newly developing leaves and shoots by the dripping of bacterial ooze in damp weather with resulting infection of the tender growing parts, or by the agency of sucking insects which may easily transfer the organisms from diseased to healthy places on the trees. It is a well-known fact that insects are frequently the agents in the dissemination of diseases of this sort, and it is probable that they are responsible to some extent for the spread of this disease, since in orchards which were visited in the early spring soon after the leaves had come out, there were found both leaf-hoppers in the adult stage and also aphids,—in some instances quite abundantly. Once a few infections have started on the newly developing and succulent leaves and shoots, the spread may be very rapid, especially in damp weather. From the fact that the bacteria ooze out from the surface of the active cankers and blighted shoots and also from the undersides, at least, of the spotted leaves, it would be easily possible for the movement of the branches and foliage to bring parts covered with this slime into contact with leaves and shoots that are healthy, and thus produce new infections. Wet weather seems to favor the spread of this disease, according to the experience of growers; and our

knowledge of such diseases would lead us to expect this to be the case. In such weather the ooze from infected tissues would run down the branches, collecting in the angles formed by the young shoots, would drip onto foliage and shoots below, and spatter around with the splash of rain drops.

Effects of the Disease. The effects of the disease depend largely on the part of the filbert which is infected, on the time of infection, and on the variety attacked. If a young shoot is infected as soon as it emerges from the bud, the whole is usually blighted back to the main twig; this may occur very quickly, so that in many instances the new leaves have attained only a very small size before they shrivel up as in Fig. 5. If it has attained a larger size, a young shoot infected near the tip will blight back for a certain distance and then, frequently, another leader starts out from the axil of some leaf farther down on the unaffected part of the shoot, as illustrated in Fig. 5. When a shoot is affected near its base, it is often girdled as in the case of that shown in Fig. 7. After a little, the whole of the new twig turns brown and dries up; and the twig very often breaks at the point where it is cankered and hangs stiffly downward. This is one characteristic of the disease which is quite conspicuous in the affected filbert planting. In fact, it is usuallly not until the dying and breaking over of these somewhat older shoots becomes frequent that growers notice that anything is the matter in the orchard. The effect of the bacteria apparently makes the wood very much more brittle at the point of attack than it is elsewhere, rendering it liable to break over at very slight contact or in a light breeze. In many cases the bacteria spread from the base of an infected shoot onto the main branch, where they cause a canker which may gradually result in girdling, with the subsequent death of the parts beyond, and usually the break

Fig. 8. The lower sides of two leaves showing the dark blotches and speckled areas typical of the disease. Bacteria are abundant in the discolored tissues.

typical of the disease. In Fig. 7 we see a blighted and broken-down lateral shoot from which infection has already spread to the main branch and girdled it, although the foliage does not yet give evidence of this fact.

When new shoots become infected, the external appearance changes very little until the tissues have become gorged with bacteria and the retarding effect upon growth begins to be noticeable. The green stems first assume a somewhat darker and water-soaked appearance, losing their bright green look and having a yellowish or brownish cast. Where the tip of a shoot is affected, or the base of a very young shoot, the developing leaves first show an unnatural, paler color, followed by evidence of retarded growth. The shoot finally becomes brown or black and, with its leaves, shrivels up, as shown at the top of the branch in Fig. 6, where every shoot has been blighted along the main axis which was itself at first healthy. When the shoots are attacked after they have reached greater development, the presence of an infection is often very difficult to detect until the leaves beyond that point begin to turn brownish and wither, or until the branch snaps and hangs down to indicate that the work of the disease has already been done.

Besides the effect on the shoots just referred to, the bacteria cause a speckling of the leaves which may develop into a condition in which a part or the whole of the leaf may become dead and withered. The first indication of infection is shown by the presence in the leaf of tiny watery-appearing areas of angular shape, bounded by little veinlets and seldom exceeding one thirty-second of an inch in diameter. They are often very numerous and sometimes so many infections occur that large areas of the leaf present a continuous dark, water-soaked appearance often surrounded by a sprinkling of speckles. After a little the spots turn dark colored or black, and on the under surface of the leaf one can often see the glint of dried-up, or in wet weather, still moist bacterial slime that has exuded from the infected spots. If a sufficient area has been involved, the whole leaf may finally turn brown and wither up. The under surfaces of typically affected leaves are shown in Fig. 8. In some cases infection may spread from the stalk of a diseased leaf and produce a canker on the supporting twig.

Fig. 9. An unusually long canker on the trunk of a susceptible tree. The bark has been cut away around the margin of the canker to show its extent.

Although it is the smaller twigs that suffer most and usually those that have appeared during the season, yet on the larger branches cankers are formed, and also on the trunk. On these older parts the cankers seem usually to have had their origin at a point where a shoot or bud had previously been blighted off by the disease. These cankers are often difficult to detect, since the bark, covering them does not change its appearance greatly at first. After a time however, the spots become

darker in color, present a sunken appearance, and may become split open longitudinally from the tensions resulting from the growth of the healthy parts that surround the dead and dried tissues of the canker. In the case of branches that are in their second season only, the presence of a canker often causes a marked constriction of the branch before there is any other external evidence of the disease. Cankers may sometimes develop far enough to girdle twigs older than their first season, but this condition is not common. It appears to be more frequent when rainy weather is continued into the summer later than usual. As far as can be judged from present observations, cankers usually cease active development as soon as dry summer weather comes on, and in some cases become healed with the formation around them of a callus. In other cases the bacteria remain alive in the tissue of the bark throughout the summer and the following winter, to become possible sources of infection for the new shoots in the spring. On the trunks and larger limbs girdling seldom occurs and little direct damage seems to result; for the cankers do not often exceed two to three inches in length, although larger ones have occasionally been found on susceptible varieties. The largest canker found by the writer was on the trunk of an Aveline, as shown in Fig. 9, where the length is twenty-one inches. The bark was cut away around the edge in order to bring out more clearly the contrast between the canker and the rest of the trunk. Cankers are typically elongate in shape. On account of the fact that there is often no well-marked line of division between cankered and healthy bark, these lesions frequently escape notice until they are quite old.

The question as to whether the filbert nuts are blighted by this disease has not been settled. That the nuts are affected frequently by some sort of disease is clear from the description appearing in the early part of this article, but microscopic examination of the exudate and of the interior substance of the nuts has not disclosed the presence of bacteria, and cultures have failed to reveal any possible parasite. The writer does not consider that the question can be answered one way or the other until further experimental work has been done and a larger number of observations made.

The frequent occurrence of blighted buds on the filbert twigs at the time of coming out and the isolation of the characteristic bacteria from such a source is another phase of the disease that remains to be discussed. In working on the bacterial gummosis of the sweet cherry, the writer found that buds which had developed normally in the summer sometimes showed within them, when examined in the middle of winter, dead beginnings of leaves and flowers. In and around these discolored inner parts were numbers of bacteria, frequently of several different kinds, and also yeasts. Such buds showed externally absolutely no sign of being different from the rest of the buds on the tree. This condition might be explained as the possible result of the piercing of the buds by sucking bugs, perhaps of the larger kinds, at some time after the development of the bud had well started, with consequent inoculation of the interior with various organisms. Many of these are apparently not parasitic, although in some cases parasites were found. It seems likely that the bud blight in the filbert may be accounted for in the same

Fig. 10. Filbert twigs in the early spring showing the presence of blighted buds.

way, by the visits of such insects late in the season and the puncturing of the buds with infected mouth parts, as in the case of the cherry. The blighted filbert buds which the writer examined frequently showed the presence of a number of organisms unlike the typical filbert bacteria. Illustrations of bud-blight appear in Fig. 10.

Summary. In brief, this disease may apparently be carried over from one season to the next in hold-over cankers on twigs and branches, and also in infected buds. It spreads rapidly in the spring as soon as the buds open and the new shoots begin to appear. It is probably disseminated by the agency of sucking insects or through the exudation of bacterial ooze during damp weather from infected parts. The green young shoots and foliage of the filbert are the most susceptible, but older twigs and larger branches frequently become cankered. The active period for the disease seems to come to a gradual close as soon as dry summer weather appears and the new growth on the trees has become more mature. Infected places may become healed, but in numerous cases living bacteria are carried over the winter in the diseased bark.

Varietal Resistance to the Disease.

A casual glance about almost any filbert planting will usually disclose a great difference in size between some of the different varieties. This is most noticeable, perhaps, in cases where the filberts are grown in the bush form, as shown in Fig. 11, but it is also evident in planting where the tree form has been adopted, as in Fig. 12. The observations of different growers and of the writer show that those varieties which are noticeably smaller and scrubbier than the rest are those which also show more severe effects from the disease. A study of the disease and its results would naturally lead one to expect that the susceptible varieties must be seriously hindered from developing to a normal size because of the continual loss of shoots every year. It seems to the writer, in fact, that the extreme difference in size between varieties in

Fig. 11. A planting where filberts are grown in bush form. To the left of the center are bushes of a susceptible variety; to the right those of a more resistant kind, and of the same age. Note the difference in size. (Gooseberries are planted between the rows.)

the orchards where observations were carried on can be accounted for on no other basis than that of difference in susceptibility to this disease.

Certain varieties appear to be entirely immune from the disease and the regular development of the trees and their large size distinguish them easily from the susceptible varieties in the orchard. It is a matter of regret, to the writer, that the identity of some of the more immune varieties found in certain plantings is still in doubt, so that their names cannot be given to the public in this report. It is to be hoped, however, that in a subsequent report we shall be able to give not only the true names of the immune or resistant varieties, but also that something more will be known as to their desirability from a commercial point of view for Oregon.

There are, however, certain susceptible varieties of which mention should be made. Among the principal filberts grown in the orchards which the writer has visited are the varieties known as Barcelona, DuChilly Cob, and the White, Red and Purple Avelines. Of these varieties, the one which is grown to the greatest extent seems to be the Barcelona. Fortunately, it appears to be less seriously affected than any of the others mentioned. It is a desirable nut commercially and has produced good yields. It is far from immune, however, as illustrated by the case of certain mature and rather neglected trees, seen by the writer, where it was found that probably over half of the bearing twigs were dead, although there was but little indication of disease on the trunks or larger branches. In well-cared-for orchards, however, the Barcelona has proved fairly profitable, and, if a sure way of combating this disease could be applied, there is reason to think that it would become a very successful variety. In regard to the other varieties spoken of, it has been found that in some plantings not over four to six years in age the Aveline and DuChilly trees, because of the effects of the disease, appear to be at least a year younger in growth than resistant varieties of their own age. In one orchard only three years old, where the filberts were growing in bush form, the DuChilly bushes were, on the average, about one-half the size of the Barcelonas. There are exceptions to this rule on both sides, but in this planting the general difference is striking.

Fig. 12. A planting where filberts are grown in tree form. A single tree of susceptible variety in the foreground with more resistant trees of the same age behind. Note the difference in size.

Certain susceptible varieties are very desirable from many points of view, but so poorly have they succeeded, hindered in development as they have been by this trouble, that many a grower has considered pulling them out. Should a successful method of remedial treatment be worked out, there is reason to think that many such varieties might still be grown with profit. Sufficient time has not been available thus far to enable the writer to make a more thorough study of the susceptibility of different varieties. Consequently, further work is necessary in this direction.

The Loss Due to The Disease.

It is not possible to estimate the exact amount of loss caused to the filbert growers of this State by the disease we have described. Filberts have been grown in Oregon to such a small extent, and for the most part for so few years, with the probable constant presence of this trouble, that the normal yield of different varieties, under normal conditions which might serve as a basis for comparison, is unknown.

That the damage done is great enough to reduce profits seriously is very evident to anyone who has studied the effects of the disease in the orchard. Buds, many of them nut producers, are blighted before they open; new shoots, some of them nut bearing, are killed at various stages of development; leaves are destroyed; the branches cankered; and it is possibly this disease which is responsible for blighted nuts. The illustrations of the disease which accompany the article speak for themselves. The results are certainly serious, and it is worth while to consider here the methods which suggest themselves as possible means of prevention and control.

Possible Means of Prevention and Control.

From a study of the disease, its life-history, and its probable cause and means of dissemination, the following methods of procedure are presented as offering possible ways by which the disease may be prevented, or the severity of its attacks diminished. This department has not yet had opportunity to test out control methods, although work along this line is planned for the coming season. Consequently, it will be understood that the following remarks are merely suggestions and not recommendations based on previous experiments. If there are any growers who would be interested in assisting the department by conducting experiments in control under the direction of the College on their own filbert plantings, we should be glad to have them correspond with us in regard to this work. Such assistance is a service to the whole State.

Resistant Varieties. The surest way to avoid trouble from the disease is naturally the planting of immune or resistant varieties. Here is presented an opportunity for those interested in nut culture to test out a large number of varieties with a view to finding those which are not only resistant to this disease, but also able to thrive and produce well under our Oregon conditions and prove to be commercially profitable. Here is an opportunity for those interested in the breeding of new varieties of nuts to work toward a strain that is resistant, as well as possessing other desirable qualities. Where it comes to a choice between susceptible varieties, it would naturally be the part of wisdom to select the more resistant, other things being equal. Of the three varieties, the Barcelona, DuChilly, and Aveline, quite commonly cultivated in this region, the first-named is found, under our observation, to be considerably more resistant than the other two.

Growing in Tree Form. It has been the observation of the writer that filberts grown in tree form, with a single trunk, develop more satisfactorily and with less of a check from the disease than those which are allowed to produce a large number of smaller and more susceptible shoots from the roots. The larger a branch becomes, the less it suffers from the effects of cankers; consequently it should be the aim of the grower to get the main framework of the tree as rapidly as possible to a size where it will not be seriously affected by such attacks. If several or many shoots are allowed to develop equally, the growth in diameter of all will be slow, and the danger period will be long.

If one or two only are permitted to develop, the structural part of the tree grows much more rapidly, and the danger period is passed more quickly.

Spraying. Since this is a disease which seems to be disseminated by the aid of insects or by the infection of young and green parts of the plant by bacteria which ooze out to the exterior from diseased tissues, it would seem highly probable that the use of sprays, both to kill the insects and to cover the surfaces of foliage and branches with a bacteria-destroying material, would result in decidedly checking the number of infections. The insecticide recommended for the control of aphids is nicotine in the form of nicotine sulphate (guaranteed 40% nicotine) used in a dilution of one part of the nicotine compound to one thousand parts of water, or twelve hundred parts of lime-sulphur or Bordeaux mixture. The writer would suggest either of these for a bactericide. Use the Bordeaux mixture in the summer strength (4-4-50), or lime-sulphur (commercial) as ordinarily duiluted for foliage application (about 1-35). The nicotine may be combined with either of these with entirely satisfactory results. The first application ought probably to be the combined spray, made just as the buds are beginning to open. The others should be made as frequently as seems necessary to keep the new foliage, as it comes out, well covered with spray. This should be continued until dry weather sets in. In the later sprays the nicotine may be omitted, unless inspection of the foliage shows that the insects are making their appearance, when another application may be made. In any spraying of this sort it is absolutely essential that a fine spray be used, and that it be applied thoroughly so as to leave no spot untouched, on the under as well as the upper side of the leaves. For this purpose, machines giving considerable pressure are by far the most satisfactory.

Pruning Out. As an accessory method in connection with the others it is suggested that growers frequently prune the disease out of their trees, cutting an inch or two below the affected part of the branches wherever possible. The bacteria found in connection with this disease seem to live a long time in the affected parts, and it would naturally be of advantage to remove from the tree as many such sources of infection as can be found. The pruning tools should always be sterilized and the cut surface of the branch washed, preferably with a solution of corrosive sublimate, strength 1 to 1000, otherwise infection might be easily carried from branch to branch and tree to tree. It is necessary to avoid the use of metal receptacles in handling this solution, as it loses its germicidal properties in contact with metal. Label it poison.

In conclusion, the writer wishes to express his appreciation of the assistance and hospitality of certain growers in whose orchards he has been permitted to work, and to thank especially Mr. Jos. Nibler of Woodburn, and Mr. H. A. Kruse, of Sherwood, who have also offered the use of their plantings in connection with certain of the writer's experiments.

Summary.

1. A serious filbert disease is prevalent in Western Oregon. It is characterized by the blighting of buds and new shoots, the speckling of the leaves, the girdling and breaking down of the smaller branches and the formation of cankers on the larger branches and trunks.

2. Bacteria of a certain distinctive type appear to be constantly associated with the disease.

3. These bacteria are believed to be the cause of the disease, but, owing to unfavorable circumstances, conclusive results were not obtained from inoculation experiments of 1914.

4. The disease is active from the time the buds open in the spring until the dry weather of summer comes on.

5. Certain varieties of filberts appear to be immune. Others are very susceptible. Among the least resistant are the Du Chilly and Aveline varieties. The Barcelona is not as susceptible as the two mentioned, but is by no means immune.

6. The following methods are suggested as possible aids in prevention and control: growing the filbert in tree form; selecting resistant varieties; spraying throughout the spring to reduce the number of infections.

BACTERIAL GUMMOSIS OR BACTERIAL CANKER OF CHERRIES.

Progress Report.

By H. P. BARSS.

Since the publication of the preliminary report on "Cherry Gummosis," which appeared in the Biennial Crop Pest and Horticultural Report for January, 1913, issued by this Experiment Station, our knowledge in regard to this disease has been greatly extended. The article referred to stated that we had proved that the common blighting of spurs and buds was due to certain bacteria. It is now possible to state that the serious cankers which appear upon the trunk and limbs of cherry trees in the western part of Oregon, and which do more damage to our young cherry trees than any other cause, may be produced artificially by inoculating with the same bacteria which are found in the blighted spurs and buds. Simple punctures made on cherry trees with a needle dipped into pure cultures of these bacteria have resulted in the death of the trees. So definite and convincing is the evidence afforded by our recent experiments that there is now no longer any doubt as to the fact that these bacteria are the cause of the disease.

In speaking of this disease, it is no longer desirable to use the term "cherry gummosis." We have substituted the term "bacterial gummosis" or "bacterial canker" of the cherry, in its place. The reason for this is that gummosis or gum production in the cherry may be the result of other causes than the attack of bacteria. In order to distinguish this particular disease, then, from others of different origin, it is desirable to use a name which will indicate the specific cause of the trouble.

Not only have these bacteria been proved to be the cause of this disease, but its life-history, its period of activity, the way in which the cherry naturally checks its advance, are now better understood. For this reason, our efforts toward control will be more wisely directed. Further investigation is necessary, however, in order to clear up some of the more difficult points in regard to the disease, and further work remains still to be done on methods of prevention and control.

The progress made in our investigation of the disease will be discussed under the following topics:

Isolation of the causal bacteria from diseased trees.
Artificial inoculations.
Points regarding the disease and its development.
Natural immunity and resistance.
A similar disease of other stone fruits.
Suggestions in regard to prevention and control.

ISOLATION OF THE CAUSAL BACTERIA FROM DISEASED TREES.

Isolations Previous to 1913. The first step in the study of a new disease is usually the attempt to discover the causal organism and to isolate the same from typical cases of the disease. For the benefit of those who are not familiar with the information contained in the previous report on this disease, a brief summary of the work up to 1913 will be given.

The discovery of the bacteria responsible for the causing of this disease was made in 1909 by Mr. F. L. Griffin at this College. In over twenty cases these bacteria were isolated during 1909, 1910, and 1911, from blighted buds and spurs. By inoculation Mr. Griffin proved that these organisms were able to reproduce the blighting of buds and spurs in a manner similar to that occuring in nature.

In 1912 the writer took up the work. In that year the characteristic bacteria were isolated from blighted buds and spurs in five cases. The work during this year was extended, however, and isolations were attempted from branch, limb, and trunk cankers, since it was the opinion of the writer that

Fig. 13. Half of this cherry tree is dead from the effects of bacterial canker, a common sight in affected orchards.

Fig. 14. This tree grew through one summer with two cankers at the base but succumbed before the next spring.

these might perhaps be caused by the same bacteria that produced the spur and bud blight. In five cases the typical bacteria were secured from branches and six isolations were secured from diseased cherry trunks.

These bacteria isolated at different times and from different parts of the trees were all tested out to see whether they could produce the disease upon healthy trees. The test proved them to be pathogenic. Furthermore, they were all like the bacteria which Mr. Griffin isolated during the preceding year except in three cases where a strain of bacteria different from those isolated by Mr. Griffin was secured, once from the base of a blighted spur, once from a branch canker and once from a diseased trunk. When grown on artificial culture media these proved to be distinct from the other organisms. Yet when inoculated into cherry trees, these bacteria of the second type, as they are designated by the writer, were able to produce disease, although this strain is evidently not so actively virulent as the other.

Isolations of 1913. During April, May, and June of 1913, isolations of the typical more virulent strain of bacteria were secured from four cases of blighted spurs or buds, and from nine cases of cankers of various sizes, upon twigs, branches, and limbs on trees of different ages. In July this strain was isolated from the trunk of a young tree seriously affected by the disease.

The second and less virulent type was also secured in two instances in May from the trunks of two trees. These organisms were all tested out and produced a diseased effect when inoculated into healthy cherry trees.

As in the preceding year, there were many attempts at isolating bacteria from diseased specimens which did not succeed. These failures were largely toward the end of the active season of the disease; that is, during June, July, and later. Attempted isolations in August, October, and November gave no results whatever. Early in the summer it was very frequently the case that many bacteria were secured, none of which seemed like those which produced the disease; and when tested out these proved unable to infect healthy cherry trees. It is probably true that in a great many cases the bacteria which cause the disease die out and that bacteria and fungi of various sorts come to infest the dead bark.

Isolations of 1914. Before discussing the results of isolation work during 1914, attention must be called to the fact that the winter of 1913-14 was unusually mild in this section of the country, and that the trees started into activity considerably earlier in the spring than is usual. Later on, during the spring, it was found that the severity of the bacterial gummosis throughout Western Oregon was very much less than in the two preceding years. Not only were the cankers smaller in extent than usual, but it seemed evident that the natural healing process by which the progress of the cankers is checked began earlier during the past season than usual. Whether the mild winter had anything to do with this condition is, of course, a matter of conjecture, but it would seem not unreasonable to suppose that it had at least some influence in this respect. However this may be, the writer found in his investigations during the spring that most of the cankers gave evidence of less active spreading than in preceding seasons, and also of quicker healing.

Successful isolations of the more virulent strain were secured, however, from blighted buds and spurs in three instances, and from branch cankers from two different sources. The second or less virulent type of bacteria was isolated in more numerous cases. They were secured from branch cankers from different sources in five instances during March and April, and from diseased trunks from five cases during March, April, and May. With one possible exception, the isolations of bacteria from either strain were pure, no other kinds of bacteria appearing in the cultures.

There were many unsuccessful attempts to secure the pathogenic organism from cases of the disease during 1914, and on account of existing conditions these failures were more numerous than during the preceding years. The fact, however, that the disease-producing bacteria were not isolated in all cases does not mean that the diseased conditions were not produced by the bacteria in question. This view is supported by the experience of many other investigators in plant diseases of this nature, and also by the experience of the writer in attempts to secure the bacteria again from cankers which he had produced by artificial inoculation.

Re-isolation Experiments. In order to demonstrate beyond doubt that an organism is the cause of a certain disease, it is considered essential that besides isolating the organism from typical cases of the disease and reproducing the disease again by artificial inoculations, bacteria shall also be re-isolated from such artificial infections. The re-isolated bacteria must be similar to the original strain and capable upon re-inoculation of producing the disease a second time. Mr. Griffin successfully made this test for the bud and spur blight in 1911. Since that time the writer has secured successful re-isolations of bacteria in no less than twelve different instances from artificial cankers produced on branches and trunks. Eight of these were re-isolations of strains of Type 1 and four of strains of Type 2. The strains thus re-isolated proved capable of again infecting healthy cherry branches upon re-inoculation.

Six other attempts were made to re-isolate bacteria from successful branch inoculations. In four of these cases bacteria were secured, but unlike the original strain and unable to cause infections. In two cases no bacteria whatever were secured in culture. These results supported also by the results of many isolation experiments on natural cankers, indicate that other kinds of bacteria, which are not disease producers, may invade cankers which were produced by inoculation with pathogenic strains. It would also appear that the disease-

producing bacteria may after a time die out from the tissues which they occupied during their active advance.

From the foregoing paragraphs it may be seen that we have been successful in securing from all phases of this disease, from blighted buds and spurs, from cankered branches, from trunks that were girdled or severely affected, two different types of bacteria, Type 1, more frequent and more virulent, and Type 2, less frequent and less virulent, both of which are capable of reproducing the disease by artificial inoculations. Both types have been re-isolated several times in pure cultures from artificially induced cankers and have again produced the disease upon re-inoculation. In no case were bacteria of both types isolated from the same canker, although in one instance they were secured from different cankers on the same tree. This work has covered a period of several years and the isolations have been made from trees which grew in many localities. The total number of isolations approximates seventy. In the great majority of cases these bacteria were secured in pure cultures from the affected tissues. No other organisms than the ones mentioned, either bacteria or fungi have been found in the diseased trees under such conditions as would lead one to suspect them of any possible causal relation to the disease. As a result of the successful isolation, inoculation, re-isolation and re-inoculation of these two types the causal connection of these bacteria with the disease under investigation has been established beyond doubt.

ARTIFICIAL INOCULATIONS.

Experiments Preceding the Fall of 1913. In the early work on this disease Mr. Griffin succeeded in causing the blighting and gumming of buds and spurs by inoculation by needle punctures with pure cultures of the bacteria which he had previously isolated from similar cases in nature. Following Mr. Griffin's work, the writer was able to secure similar results by inoculation with strains which he had secured not only from blighted buds and spurs, but also from branch and limb cankers as well as from diseased trunks. A slight response was also secured when inoculations were made on the limbs and trunks of healthy trees.

During the spring of 1912 altogether over 200 inoculations were made with bacteria of Type 1, 80% of which gave a definite and positive response. With the less virulent Type 2 there were 175 inoculations made, over 50% of which resulted in positive infections. All inoculations apparently healed during the later part of the spring, and there was no spread from any of them later, as shown by observations taken the next year.

Further inoculation experiments were conducted in the spring of 1913. Bacteria which had been isolated in previous years were tested out to learn whether or not they had retained their virulence. A strain isolated by Mr. Griffin in 1911 was able to produce active infection after having been kept in artificial culture for two years. Fifteen different strains isolated the year before were also tested out and gave active infection. In fact, these old strains seemed to be no less virulent than half a dozen fresh strains isolated only a few weeks previously and tested at the same time. During June and July, inoculations were also made with newly isolated strains of bacteria. In this way during the first half of 1913 over 75 inoculations were made on branches and trunks of cherry trees with virulent strains and only one failure to infect was recorded. As in previous years, check punctures were made in all cases with sterile needles, but none of these ever showed any sign of disease at the puncture point, except in a very few instances where a natural canker involved a check puncture in the course of its progress. In addition to the puncture checks, check inoculations were made from time to time with strains of bacteria different from the two types mentioned. In no case was any response secured from inoculations with such organisms.

All of these inoculations gave very slight results when compared with the natural effects of the disease in the orchard. Buds and spurs were blighted, it is true, very much as in nature, but where inoculations were made upon the

Fig. 15. A four-year-old Royal Ann girdled as a result of a needle-prick inoculation with a pure culture of canker bacteria in October, 1913. Photograph taken April 20, 1914. Foliage development is much retarded but leaves show no sign of wilting.

Fig. 16. The same tree as in Fig. 15 photographed July 3, 1914, after the leaves had dried up. Suckers are arising from the still living base of the tree, as is often the case after natural girdling.

branches and trunks, no results were secured comparable with the ordinary manifestations of the disease in our cherry plantings. The successful inoculations showed a certain amount of gum exudation and the tissues of the bark always died about the point of inoculation, but in most cases the dead area was not more than half an inch in length and even in the most extreme cases it was hardly more than an inch. Although remarkably uniform, all these inoculations were far from satisfactory to the investigator. If, as seems to be the case, these bacteria are able in the orchard to produce large cankers, girdle limbs, or to kill trees, why, then, should they not do so when inoculated artificially into susceptible trees? The answer to this question came through the work of the fall, winter, and spring of 1913-14.

Experiments of the Fall, Winter, and Spring, 1913-14. On October 23, 1913, 14 cherry trees which had passed the fourth summer of growth in the orchard were selected for inoculation work, on account of their healthy appearance and freedom from evidence of previous natural attacks of disease. Using a sterilized glover's needle, two punctures were made on each trunk at some distance from each other and two on each of two main branches. A sterile platinum needle was dipped into a tube of peptonized beef broth in which a pure culture of bacteria had been growing for several days. The needle was then inserted into one of the punctures which had been made on the trunk and on

each of the two branches. The remaining punctures were not inoculated and served as checks. Different strains of bacteria were used for the different trees. They had been isolated from different cases of the bacterial disease during the preceding spring.

Sixteen days later an examination was made of the trees which had been inoculated in this way. In most cases there was a very slight darkening at the point of inoculation which did not appear at the check puncture. On some there was also a very slight, but distinct flattening of the bark close to the inoculation point.

Twenty-three days after the date of inoculation, examination was again made. Every tree showed definite evidence of infection. There was a slight sinking of the bark in the neighborhood of the inoculation and at the point of the puncture a small drop of gum had in many cases exuded. None of the check punctures showed any effect whatever.

Examination one month after the inoculation showed very little further development, although in some cases the depressed area about the inoculation was very evidently increasing in length.

Fifty-six days after inoculation examination of the inoculated points on the branches was made by means of the knife, and it was found that in all cases an area of discoloration had spread out from the point of inoculation. The total extent of the discolored area of the bark varied from something like half an inch to an inch and one-half, the average being three-quarters of an inch. An exudation of gum was present in some cases but not in others.

About three months after inoculation the remaining branch cankers were inspected by cutting. It was found that very little advance in length had been made since the investigation about a month before.

On February 16, four months after inoculation, another investigation was made and it was noted that in some cases the trunks appeared to be very seriously affected. No inoculations were cut into. Many of the infections, however, were showing very decided exudations of gum and the presence of gum blisters, sometimes several inches from the point of inoculation.

Five months after inoculation, on March 21, it was found upon examination that five of the trunks had been girdled by the disease. In certain other cases the trunks were nearly girdled, and in still others large cankers were present.

In the spring all the trees came out into leaf and bloom, but on April 20 it was very noticeable that the foliage on the trees which had been girdled was lighter in color and smaller in size than on neighboring healthy trees.

On May 27, another set of observations was made and it was found that the cankers had not made any further progress since the observation on March 21. Callus formation had commenced and, so far as could be observed, healing was in progress in all cases except where girdling was complete.

In the case of the trees that were girdled, it was not until late in the spring, or in some cases until the beginning of the summer, that they showed complete withering of the foliage. Even as late as November, 1914, it was observed that although the leaves and buds had died, on one of the girdled trees, the bark on the central branch was still apparently alive. These trees did not die simultaneously or suddenly. One after another they gradually wilted down, the leaves becoming yellowish, finally turning brown, withering and hanging to the trees for a long time in this condition. In most of the cases suckers appeared from the healthy part of the trunk underground or at the still living base of the tree above ground. In one instance a single sucker which appeared died off afterwards. In no case were any of the checks affected until after the canker had progressed so far as to involve the point at which the check puncture was made.

To summarize the results of the inoculations of October 23, 1913, out of the 14 cherry trunks which were inoculated with different virulent strains of bacteria, five trunks became girdled and the trees died. Three trees showed a death of more than half the circumference of the trunk, and three trees had large cankers from seven to ten inches in length. The three remaining trees were all stunted Lamberts, and on these were produced cankers one inch, one inch, and two inches in length respectively. From a study of these records,

Fig. 17. Branch cankers photographed in May, 1914. Beginning at the left, the first shows a canker 12½ inches long resulting from inoculation in December, 1913, with a strain of Type 1. The second shows a canker 5 inches long resulting from inoculation with a strain of Type 2 on same date. The third shows a canker 10 inches long resulting from a natural infection. Note the gum exudations in all these cases. The fourth is a natural canker one year older than the others. There was no spread after the first spring and a vigorous callus is closing over the wound in the usual manner.

it would appear that the spread of the bacteria in the tissues of the bark was most rapid during February and the early part of March, while the cankers ceased their development before March 21. The cankers apparently developed slowly until after the middle of January, or the beginning of February, and then a rapid expansion took place, which came to a sudden termination some time during March. It must be understood that these were the conditions during a winter which was marked by unusual mildness. Just what the rate of progress would have been or what the date at which the expansion of the cankers would have ceased under more severe winter conditions, is a matter of conjecture.

At last, by inoculating in the fall of the year, it was possible, by artificial infection, to produce effects as serious as any that have been found in nature. Furthermore, the progress and development of the disease induced parallel in a remarkable manner the progress of the disease as it has been observed in our cherry orchards from year to year.

On November 1, 1913, a number of inoculations were made in the experimental orchard to determine whether the cultures which had been isolated in previous years had retained their virulence. This set of inoculations demonstrated conclusively that the bacteria in almost all instances had retained their vitality for a year and one-half, and in two cases for over two years and one-half. In other words, the oldest cultures which the writer had in his possession were still capable of virulent activity when inoculated into healthy trees.

On December 16, 1913, inoculations were made with isolations of the preceding spring on healthy branches of trees which had been selected for their susceptibility to the disease. Previous to this time trees had been selected for inoculation which had shown no old, natural cankers. As a consequence, some very dwarfed small trees of a resistant variety had frequently been inoculated with comparatively poor results. From these later inoculations with virulent bacteria on susceptible trees, however, very large and conspicuous cankers resulted in all cases. The cankers ranged from five inches to three feet in extent, some of them girdling and others nearly girdling the branches which had been inoculated. Observations show that there was no increase of size in these cankers after March 21, as was the case with the inoculations made earlier in the fall. These cankers all healed up during the spring, and have, up to the present writing, shown no indication of extending beyond their original limits.

On February 7, and again on February 11, inoculations were made on branches and also on trunks of four-year-old trees. Final observations taken on the branch inoculations show that the cankers average about three inches in length, none being over five inches in extent. On the trunks, the extent was about the same, with one exception. Curiously enough, this was an inoculation made with the original strain isolated by Mr. Griffin in 1911. The canker in this case reached an extent of 9½ inches.

Encouraged by the results of the inoculations commenced in the fall, the writer began a large series of inoculations in order to determine certain points relative to the disease. These were carried on during the course of the winter and throughout the following spring and summer. In all, over a thousand inoculations were made. In no case, however, did inoculations made after the middle of February, 1914, result in a canker of more than an inch and one-half or two inches in extent. The majority did not reach the extent of a single inch. Furthermore, all inoculations up to those made last September have apparently healed. Gum exudation followed practically all inoculations, and was often copious even where the inoculation canker was only very small in extent.

It should be noted in connection with these experiments that where trees were killed from the inoculations in the fall, gum exudation was often not a conspicuous phenomenon, especially at first. Usually a very slight exudation of gum occurred at the point of inoculation. Then for a long period of time there would be very little evidence of gum, either at the point of inoculation or in the area through which the canker was spreading. Early in the spring,

however, gum exudation become in general more pronounced. Gum flow did not ordinarily come from the cankered tissue itself, but from the border line between that and healthy bark. On the average it was not so abundant in the serious cases as it was in those which were only moderately severe. Some of the girdled trunks showed hardly any gum. Another interesting observation was made in connection with this work; namely, in the most severe cases the sour smell which is characteristic of the sour sap condition of fruit trees was quite conspicuous in many instances. Sour sap, then, may accompany or be the effect of this disease. This confirms the suspicion which the writer has had for some time as a result of observations upon various diseased cherry trees in the orchard.

The successful inoculations of the past season as just described, have not only set at rest all doubt as to the nature of the disease which has given our cherry-growers so much concern, but they have also, in connection with continued isolation work and constant field observations, given to the investigator a great deal of added information in regard to the life-history of the disease which will be discussed in the following section.

POINTS REGARDING THE DISEASE AND ITS DEVELOPMENT.

How May the Disease Be Carried from One Season to the Next? This question is a difficult one to answer. It brings up the whole matter of infection and dissemination, about which it must be admitted very little is as yet known. Observations have been made, however, with this question in mind, and it may be well to discuss some of the conclusions to which they have led.

Spread from Old Cankers. It is certainly true that in a great majority of cases the disease does not spread from old cankers, and yet numerous instances are found from year to year which give support to the idea that occasionally, at least, bacteria do spread out from the old cankers, and extend the wound in succeeding seasons. The writer himself has found cases which appear to be examples of this. Even in such cases, however, appearances are likely to be deceptive. Knowing that bacteria are the cause of this disease, it is natural to suppose that a large and active canker would be the source of numerous infections, which might develop, especially in its immediate neighborhood, the next season. In this connection orchard observations have shown that in general, although there are exceptions, trees which exhibit more numerous points of infection than the other trees in the orchard are generally such as have been infected in previous years. It is doubtful, therefore, whether or not the apparent spread from old cankers is anything more than new infections developing around the border of the old cankers. Under any circumstances, however, the spread of old cankers would explain only a very small proportion of the new infections that occur.

Bud or Spur Infection. In February, 1914, it occurred to the writer that he might be able to get evidence of the occurrence of new infections previous to that date, by bringing in cherry branches and forcing them out in jars of water in the laboratory. A considerable number were taken from the experimental orchard where bacterial canker was quite prevalent the previous year, and forced into bloom. When brought into the laboratory, all the buds looked healthy, but at the time when the majority opened, some failed to expand. Investigation of the latter disclosed the fact that while the exterior of such buds appeared perfectly normal and the inner scales themselves in many instances looked perfectly healthy, yet in the interior of the bud some or all of the small beginnings of leaves and blossoms were discolored or shriveled. These buds had apparently all developed in a perfect manner through the summer, and then, with no external indication of the fact, the interior parts, some or all of them, had become blighted before the date of investigation in the middle of the winter. In the majority of cases there were present in the dead parts, as determined by examination and culture work, bacteria, yeasts, and fungi, sometimes a single organism pure, sometimes a mixture of organisms. In two instances no organism was found and in three cases bacteria

of the disease-producing kind were isolated, the other forms secured being apparently purely saprophytic.

The only explanation for this condition which the writer has to suggest is the possibility that these buds had been visited during the autumn by sucking insects, such as the larger plant bugs, that these had pierced through the outer scales with their mouth-parts and had injured the delicate structures within, sometimes also introducing organisms of one sort or another. Where the organisms were not like those of the disease we are discussing, the writer never found any tendency for them to spread from the bud into the spur or branch which bore them. On the contrary, in every case where the typical cherry-disease bacteria were found, there was definite indication that they were spreading into the tip of the spur or back into the twig. If insects do attack buds in the manner suggested, it is easy to account for the large number of blighted buds and spurs which are present in diseased orchards every spring, for an insect could not fail to inoculate the next spot punctured after it had pierced tissues containing living canker bacteria.

It is a well-known fact that the majority of branch cankers seem to originate from a blighted bud or spur, and this is also frequently true of trunk cankers. If sucking insects are responsible for bud and spur blight, then it is not unlikely that a large proportion of the cankers also may thus result indirectly from their work. It must be understood that the possible relation of insects to the disease has not been demonstrated scientifically. The foregoing remarks merely suggest an explanation for conditions which demand further investigation before definite statements can be made.

Infection not associated with Buds or Old Cankers. Cankers are sometimes found which have no apparent connection either with blighted buds or spurs or with old cankers of a previous season. It is possible that such infections might be caused by the puncturing of the bark by sucking insects with infected mouth-parts. There are certain insects, also, that possess the habit of laying eggs in punctures in the bark. If such an insect should pierce a tree at a point where the bacteria of disease were present in a living condition, it could not avoid carrying some of the organisms to other places on the same tree or different trees visited during oviposition. Although there is no scientific proof that the disease has been carried in this manner, yet it is quite probable that such infections may occur. It is also likely that infection may occur in ways which have not been suggested, and further work is planned in this connection.

What Is the Period of Infection? It might be natural to expect that the period of most abundant infection would be in the spring when the bacteria are most active in the cankers. The writer, however, has carried on many hundred inoculations covering all periods of the year and in no case have the inoculations which he has made during any of the spring or summer months caused the formation of cankers during the following winter. Infections made in the fall of last year, however, did produce serious effects by the following spring, and autumn inoculations of this year give promise of the same results. The conditions under which artificial inoculations are made are, of course, not like those under which infections would occur in nature, yet in view of the careful experiments conducted it would seem likely, at least, that the serious infections do occur after the end of the summer. It is not at all impossible that infections may also occur every spring, but such infections would probably spread for a very short time only, after which the development of callus by the host plant would prevent further advance. The fact remains, however, that even though it appears that fall infections must be the most common, yet the bacteria must remain alive over the summer in the orchard. It is possible that they continue to live in the margins of some of the old spring cankers or in blighted spurs and that such hold-over cases would be sufficient to account for the new infections which occur every year. Further investigation of these points in regard to the disease is very much to be desired.

The Season of Most Active Development of the Disease. All the obser-

vations which have been carried on during the past few years in the orchards where this disease is present, combined with all the evidence from artificial inoculations, indicate that while the disease starts in with a slow development in the fall, it spreads most actively in most cases, at least, during the later part of the winter, coming to a sudden halt early in the spring. Beginning with February 11, and continuing every two weeks until the later part of June, inoculations were made on the two-year-old branches of young cherry trees. The number of these inoculations was over 400. Every two weeks some of the inoculations that had been made on the previous dates were cut off with a knife and measurements were made later of the extent of the cankers. The results were striking. In the inoculations of February 11, the spreading of the bacteria in the tissues ceased within one month from the time of inoculation. In the case of all succeeding inoculations, they ceased within two weeks of the time of the inoculation. During the season of 1914, then, it is apparent that the most active spread occurred previous to the middle of March, after which time infections were promptly checked by the activity of the tree in forming a wound-cork layer. What the period of active spread in nature may be, is somewhat a matter of conjecture, but apparently it is about the same as in the case of the artificial inoculations. It must be taken into consideration, however, that climatic factors and the condition of the trees may have a large influence in different years on the active period of this disease.

The Natural Means by Which the Disease is Checked. The investigation of numerous cases of natural infection and also of a large number of artificial inoculations, has shown that at the time when the cherry trees begin their activity in the spring, a very delicate layer of cells is formed between the infected portions of the bark and the still healthy part. If the spread of the bacteria is very rapid, it frequently happens that the canker advances beyond the first barrier thus formed, but eventually a partition of cells which we know as wound cork is formed, of sufficient thickness to prevent any further spread. Subsequent to the development of this wound cork, a callus formation commences, first in the cambium region. This callus increases gradually and in the case of small cankers the wound may be almost completely healed over during the spring and summer following the infection. Callus development is naturally more vigorous and rapid on trees that are in a healthy and rapidly growing condition. In most cases the canker is thus checked completely during the first season, although it may possibly be true that a spreading of the old canker does, occasionally, take place the following winter.

Wound Parasites and Heart Rot. In nature the dead bark of a bacterial canker presents a perfect, natural port of entry for other undesirable organisms. There are a large number of different fungi which may attack dead bark. These are known as saprophytes. In some cases these saprophytes, after getting a start on the dead bark or in dead wood, may spread farther, entering the living sap wood or the living bark as parasites and greatly extending the injury commenced by the original bacterial canker. The writer has observed many instances where wood-rotting organisms have started at old cankers and finally caused the destruction of limbs and in some cases of entire trees. It is thus evident that the injury resulting from the bacterial disease in many cases does not stop when the active canker ceases its spread, but may be continued by these wound parasites and wood-rots in subsequent years, often with fatal results to the tree.

NATURAL IMMUNITY AND RESISTANCE.

Following out the observations made in the years previous to the publication of the first Biennial Crop Pest and Horticultural Report, the question of natural immunity and resistance has been further studied. It has been found that sour cherries are attacked not at all, or at least only very slightly by this trouble. Among the sweet cherries, the May Duke has been found cankered to a very small extent and in one instance the typical cherry bacteria were isolated from such a canker. The effects of the disease on this variety, however, are not severe enough to cause any appreciable loss whatever. In regard to the

immunity of Mazzard seedlings, it may be stated in general from the observations of plantings at different places in the State that the vast majority of seedlings seem to be highly resistant to the disease. In a certain young orchard where 250 seedlings were planted, and afterwards limb-grafted to commercial varieties, it was found that only in two cases did the trunks show the slightest signs of anything that might be considered similar to bacterial canker. The susceptible tops showed occasional instances of the disease, but these were much less frequent than in the average orchard in which the trunk is also susceptible. In the College orchard at Corvallis, sweet cherry seedlings have been planted for experimental purposes, most of which are easily distinguishable from the common commercial varieties, especially from the Royal Ann and Bing, by their large size, and freedom from any indication of canker. It is true that in occasional instances seedlings are susceptible, but in our experience these represent a very small percentage of the total number.

Of the three commercial varieties of sweet cherries, Royal Ann, Bing, and Lambert, it was stated in the previous Biennial Crop Pest and Horticultural Report that orchard investigations showed that the Lambert was a good deal less susceptible than the other two varieties. As a result of artificial inoculation work which the writer has conducted recently, it has been found that the cankers thus produced reach a much smaller development on Lambert trees than they do as a rule on the other two varieties. It is also true that the Lambert trees in the experimental orchard are conspicuously slower growing and smaller in size than the other two varieties. There may thus be a possible connection here between rate of growth and natural resistance. Observations continue to show that old trees suffer comparatively little from the effect of the disease under consideration. In old trees the damage is largely confined to a blighting of smaller branches, spurs, and buds, and is not usually serious. It should therefore be the aim of the cherry grower to care for his trees so vigilantly during the first five or six years of their growth that they will reach the age of natural resistance without having suffered greatly from this disease.

A SIMILAR DISEASE OF OTHER STONE FRUITS.

During the course of the investigations upon the bacterial gummosis of cherries, attention has also been given to similar troubles affecting other stone fruits. A disease of prune trees has been known in this section of Oregon for a long time under the designation of "Winter Injury" or "Sun Scald," in which large cankered areas were formed on the trunk and branches. The exact cause of this trouble was not definitely known. It has recently been proved by certain experiments made under the direction of this department, that the action of the sun, in some cases at least, has nothing to do with the formation of such lesions. When the writer took up the work on cherry diseases, he noticed that these prune cankers were quite similar in many respects to those which were present on the cherry trees. It is true that there was rarely so profuse a gum exudation from the prune trees, but in examining specimens of the trouble, bacteria were sometimes found present in the diseased bark. During 1912, Mr. H. L. Rees, at that time connected with the department of Botany and Plant Pathology at this institution, succeeded in four different instances in isolating from diseased prune trees from different localities, strains of bacteria which looked exactly like those Mr. Griffin and the writer had secured from diseased cherries. Mr. Rees made inoculations with these strains in July, 1912, on prune trees in an orchard near Salem. Six weeks later records were secured showing that out of 78 inoculations on 26 trees there were 59 which showed a slight dying of the tissue around the inoculation point, or some exudation of gum, or both. In other words, 75% of the inoculations showed a response not evident at any of the check punctures. No further effects were apparent, however, although observations were again made about a year later. The writer later tested out these strains on cherry trees and found that they were exactly as virulent as those isolated from the cherry disease. During 1913 and 1914 the writer succeeded in seven different cases in isolating from diseased Italian prunes bacteria which produced

on cherry trees exactly similar results to those produced by the cherry organisms. No difference can be seen in cultures between these bacteria and those from cherry, and every evidence goes to indicate that they are identical.

During 1914 in an orchard near Salem the writer made inoculations upon young prune trees with bacteria isolated from prunes and other stone fruits. From January to October, inclusive, a set of inoculations was made about the middle of each month, and observations were recorded at regular intervals. A slight exudation of gum occurred in a few cases, but there was never any external indication of the formation of such cankers as were being produced on cherries by inoculations made with the same strains of bacteria at about the same time. In December, 1914, the final observations on this series of prune inoculations were made and the bark was cut into with the knife. It was then found that, although there was as a rule no external indication of the fact, yet within the bark evidence of definite effect was present in the case of many of the January and February inoculations and was commencing in the October inoculations, while practically no result was apparent from the inoculations of the intervening months. In the cases where positive results were secured, it was found that although the outer layers and inner layers of the bark were perfectly healthy, except very close to the inoculation puncture, yet for a considerable distance above and below this point a thin brown layer of tissue or separated brownish streaks or specks were present in the middle layer of the bark, or what is known as the pericycle region. Microscopic examination showed that the discolored tissues were composed of dead cells surrounded by a wound cork sheath, which completely separated them from the healthy bark. In such cases, then, the bacteria apparently worked their way up and down through this middle region, with little damage to the whole bark and with no resulting external evidence of the fact. Seventeen different strains of bacteria were used in the inoculations of January and February, five of which produced no apparent result. Fifty-one inoculations were made from the other twelve strains; of these 65% gave positive results varying from a little over half an inch to over eight inches in extent and averaging about three and a half inches. These were all made on young trees from one to three years of age. The inoculations of January gave slightly better results than those of February, and the inoculations on the older trees gave more extensive discoloration than those on the year-old trees. The results thus obtained on the prune are not nearly so uniform nor so serious as the results that have been secured under similar conditions on the cherry. What would have taken place had the inoculations been made in the fall of the year or on older trees cannot be stated from present knowledge, but it would not be surprising to find that inoculations made under the proper conditions produced exactly as serious cankers as any found naturally in our prune orchards. Further work is now in progress in this direction and report will be made later as the results are secured.

In the spring of 1913 a specimen of girdled peach tree was sent to the College, and from the dead bark bacteria like the strains from cherry were isolated in pure culture. In 1914 similar bacteria were isolated from a young peach tree, the trunk of which was nearly dead as a result of the disease when sent in from Three Pines, Oregon. These strains have produced active effects when inoculated on cherry trees. Tests with them on the peach have only just begun and a report cannot be made.

In 1913 specimens of apricot branches bearing serious cankers were sent in to the department from Portland. From these branches a strain of bacteria like the typical cherry organism was secured in pure culture, and inoculation has shown this to be one of the most virulent strains which we have ever used in making cherry inoculations.

During 1913 it was also found in the College planting that a young specimen of *Prunus simonii* was affected with serious branch cankers. Bacteria were found in the dead bark, and cultures gave a pure isolation of a strain like the cherry bacteria. Inoculations with this strain on cherry trees subsequently have proved it to be exceedingly virulent.

Present information seems to indicate, therefore, that the bacteria responsible for our cherry disease also produce disease on other stone fruits. In many peach orchards the writer has frequently noticed cankers, on the trunks and branches of the trees, although they have not attracted a great deal of attention from the growers. Prune cankers, however, are quite common, on young trees especially, and have caused considerable damage. It is true that canker troubles do not seem to be so serious on other stone fruits as on cherries. They are serious enough, however, to warrant the further investigation projected by this department. It should be mentioned that re-isolations from three strains of prune bacteria, one of peach, two of apricot, and one of *Prunus simonii* have been made from cankers produced artificially upon cherries, and that re-inoculations made with these strains on cherry have proved them to be pathogenic. The strains which have been isolated from cankers of other stone fruits have resembled Type 1 of the cherry bacteria in every case thus far.

SUGGESTIONS IN REGARD TO PREVENTION AND CONTROL.

Resistant Seedlings. In the previous report on cherry gummosis, it was recommended that the growers use Mazzard seedlings, and then graft the desired commercial varieties into the limbs. Since writing the previous article, the writer has learned that various sorts of sweet cherry seedlings are probably being sold under the designation Mazzard. The orchardist naturally cares very little whether he gets a genuine Mazzard from its native woods in Europe or some other sweet cherry seedling, provided it shows resistance to bacterial canker and thriftiness of growth. A grower, therefore, who intends to set out seedling stock, ought to know just what sort of stock he is getting and whether or not it is resistant to the disease.

There are growers in the State who raise their own seedlings. Some of them get their seed from certain old seedling trees of unusually vigorous growth whose smooth, clean trunks and branches attest the fact of immunity from the bacterial canker, and whose seedling descendants year after year have never shown any signs of susceptibility. A grower may feel safe if he has such a source to go to, where the test of time has proved its reliability.

It is recommended that after growing the seedling in the orchard for two years or longer, if desired, the grafts or buds be set into the limbs, and not upon the top of the trunk itself. The reason for this is shown in actual experience, since where this method is adopted it is impossible for cankers to start in the crotch and spread, from one limb to another, as is frequently the case where trunk grafting was the method employed. Wherever

Fig. 18. One of the limb-grafted seedling trees in an orchard where less than one per cent of the trunks showed any sign of disease and the tops were unusually healthy.

seedlings are used as described, not only are clean bodies the result, but a notable decrease is always found in the amount of disease present in the susceptible top.

Resistant Varieties. Continued observations prove that the Lambert is more resistant to bacterial canker than are either the Bing or the Royal Ann varieties. In some cases, it is true, trees of the first-mentioned variety are seriously affected, but in general the other varieties suffer much more severely. It is very evident that we have altogether too few commercially desirable varieties to select from. Here is presented a splendid opportunity for interested cherry growers of Oregon to develop a variety which will be commercially desirable and profitable and at the same time resistant to this discouraging disease.

Cutting Out the Disease. The more general adoption of surgical methods in the treatment of this disease is strongly desirable. There are two reasons, especially, why this method is worth while. Wherever cankers on the body or main limbs of the tree are discovered before they have reached their fullest extent, the cutting-out method will check their further development and the natural healing of the canker will be much more rapid than in cases where the canker is left to itself. In the second place, the cutting out of the cankers removes from the orchard sources of infection for the following year. This is perhaps the most important reason for doing this work. It is therefore recommended that beginning late in the winter or very early in the spring, the trees should undergo periodical inspection for any evidence, even the slightest, of apparent new cankers. When infections are discovered they should be cut out at once. All bark that has an unnatural appearance in the neighborhood of an infection should be removed. The wounds should be cut out clean, and, if done early in the season, the cutting should go some little distance beyond the apparent extent of the injury, especially at the upper and lower ends, since bacteria may be present in the tissues beyond the evident discoloration. The wounds should be washed out with a solution of corrosive sublimate, 1-1000, in order to kill all of the bacteria that may be present on the surface. The cutting instruments should also be sterilized, and the strips of bark which have been cut out should be carried away and buried or burned. In case the wound is at all large, a good tree paint should be applied, as soon as the surface of the wood has dried, in order to prevent the entrance of wound parasites and heart rots which are among the most dangerous enemies in our fruit orchards. The corrosive sublimate may be secured at any drugstore, and directions for making the proper strength may be secured of the druggist. This solution deteriorates when kept in metal receptacles. It is best to keep it in a glass bottle which should be labeled "Poison." The solution may be applied with a cloth swab on the end of a stick, or with a sponge. It should be mentioned that in the winter pruning of a young cherry orchard where the disease is present, growers ought to disinfect the pruning instruments with this solution and swab the cut ends of the branches as is done in the case of pears and apples where fire blight is prevalent. A great deal of benefit has resulted from the adoption of surgical treatment in some of our young orchards, and this method is strongly urged upon the growers. The earlier in the life of the orchard such treatment is begun the less difficult will be the work of the grower in succeeding years, because of the extent to which new infections may be prevented by this method. It would of course be impossible to eliminate the disease entirely from the orchard by cutting out. No one can detect all the minor infections that are present in the trees, but all the more serious cankers ought to be taken care of. By using this treatment the amount of infection may be reduced, the natural healing processes accelerated, and the entrance of wound parasites largely prevented.

The Wrapping of Trunks and Limbs. A new method is being tried out by several growers which gives some promise of success. It is too early yet to determine the amount of benefit which will result, but a careful watch is being kept of these experiments and further notice will be given if it proves satisfactory. The method consists in wrapping the trunks and limbs with coarse cloth or burlap and allowing these wrappings to remain until the tree

has passed the age of danger. Bacteria are the cause of the disease and infections can only take place by the transfer of bacteria to healthy trees from

Fig. 19. View in an orchard where the owner is trying to combat bacterial canker on the body of his trees by wrapping with burlap. It is not yet known how successful this method will prove to be.

infected sources. It is probable that insects are the agents principally responsible for this transfer. Hence it seems reasonable that if the trunk and limbs are covered with something which will prevent the attacks of insects, no new infections will probably occur on the parts thus protected. If this treatment is begun when the trees are set out and continued for a number of years, readjusting the wrappings each year to keep pace with the development of the tree, the result ought to be clean limbs and trunks—at least theoretically. The department of Botany and Plant Pathology would like to see this method tried further in an experimental way, and we solicit correspondence from growers who would be interested in assisting us by testing it out.

SUMMARY.

1. It has been proved by a large number of successful isolations, inoculations, re-isolations and re-inoculations that the most serious disease of sweet cherries occurring in Western Oregon is caused by bacteria. There appear to be two slightly different kinds of bacteria, and only two, which are capable of producing the disease.

2. The disease in nature causes a blighting of buds and spurs and the formation of cankers on branches, limbs and trunks which often result in the death of the parts attacked. These effects have all been reproduced by artificial inoculations.

3. The exact manner in which the disease is disseminated is not known, but indications seem to point to the possibility that sucking insects may be largely responsible for infections.

4. The period of most serious infection is believed to be the autumn. The new infection appears to develop slowly at first, gradually gathering momentum and reaching its maximum rate of advance in the late winter or early spring.

5. The progress of the cankers usually receives a sudden check through the formation early in the spring by the tree of a wound-cork barrier followed by callus formation. Cankers seldom or perhaps never spread after the first season.

6. Wound parasites and wood-rotting fungi frequently enter at the cankered spots and extend the injury originally caused by the bacteria.

7. Observations point to the general resistance of the so-called Mazzard seedlings to the disease. Among commercial varieties, the Lambert is more resistant than either the Royal Ann or Bing.

8. A similar canker disease has been found on prunes, peaches and apricots, and pathogenic bacteria apparently identical with the cherry organism have been isolated. The effects on other stone fruits seem to be in general less serious than on the cherry.

9. It is suggested as a means of prevention that resistant seedlings be planted and limb-grafted to the commercial varieties later. Surgical treatment is recommended for control of the disease in the orchard and the wrapping of trunks and limbs for the prevention of infections is a method proposed for trial.

EXPERIMENTAL SPRAYING OF PRUNES FOR CONTROL OF BROWN ROT.

By F. D. Bailey.

During the seasons of 1913 and 1914, spraying experiments have been conducted in cooperation with growers in several sections of the State, attempting to control Brown Rot of stone fruits. While we are not able to make definite recommendations as yet, certain facts and conditions that have developed in connection with the experiments seem worthy of record.

In 1913 the work was confined to the Chehalem Orchard Company's orchard at Newberg. Here a block of about eight acres of 22-year-old Italian and Petite prunes was selected. Three spray mixtures were used for the first application, which was put on between June 6 and 9. The mixtures used were Bordeaux 3-6-50, self-boiled lime-sulfur 10-10-50, and commercial lime-sulfur 1 to 40, four hundred gallons of each mixture being used. The crop was very light on the Italians this year, but it was hoped that with the experiment under way, the beneficial results, if any, might be cumulative. In case spraying should prove effective one year, it was hoped that the sources of infection would be correspondingly reduced and less rot appear the year following.

Following the time that the first application was made, no brown-rot infection appeared for over two weeks. About June 26 a small percentage of infection was observed in two orchards near Corvallis, and on June 29 a similar condition was observed in the Newberg orchard, the infection having taken place in all cases at practically the same time.

To check on the efficiency of the different sprays, a count was made of the brown rotted fruit that had fallen. One row (No. 6) through the experimental plot, across the spray and check plots, was selected. These figures, when compared with the entire yield of these same trees at the end of the season, are shown in Table I. An average of several tests showed that fifteen prunes to the pound was a fair basis to estimate work on, this being the weight at picking time. At the time when this first check was made, it was very apparent that slight foliage injury of the Italians and spotting of fruit of the Petites had resulted from the use of the commercial lime-sulfur.

The second application of spray was made from July 7 to 9, and the same mixtures were used as in the first instance, with the exception that the Bordeaux plot was divided in such a way that Bordeaux mixture 4-4-50 was used on six rows, and Burgundy 2-3-100 was used on the other six. At the time this application was made, there had been very little new infection since June 29.

An examination of the results was made on this application on August 9, following a second infection and rather heavy fall of fruit. This check was made on a different row across the entire experimental plot from the one used in making the check on the first spray. It might be stated that these two check rows, No. 5 for this second spray and No. 6 for the first, run north and south, at right angles to, and crossing, the spray plots. At the time this second check was made, it was not always possible to tell whether the fruit on the ground dropped because of brown-rot infections or some other cause. Care was exercised, however, to make a count that would be as nearly as possible an index of the loss due to brown rot. The result of this count is given in Table I.

It had been the intention to make a third application just prior to harvest, but when the orchard was visited on September 10 but few scattering infections were found, and such a poor yield occurred that it was deemed advisable to omit this spray.

On September 17 and 24 the prunes in this part of the orchard were harvested, and Mr. G. H. Godfrey took the yield in weight of each tree in rows 5 and 6, which had been used to check on the experiment in the summer. On this yield a fair comparison is obtained when the loss due to rot is reduced to percentage and an average taken of several trees subjected to the same treatment. Thus we see that during the June period of infection, the crop was

Table I. Showing Count and Percentage of Fruit Rot on Two Rows Across the Sprayed and Check Plots as determined by the yield of Individual Trees.

ROW NO. 6, NORTH AND SOUTH.						ROW NO. 5, NORTH AND SOUTH.				
Tree number.	Infection June 29, 1913, number of prunes.	Pounds prunes harvested September 17, 1913.	Pounds prunes harvested September 24, 1913.	Per cent of rot.	Average per cent.	Infection Aug. 9, 1913, number of prunes.	Pounds prunes harvested September 17, 1913.	Pounds prunes harvested September 24, 1913.	Per cent of rot.	Average per cent.
BORDEAUX MIXTURE.						BORDEAUX MIXTURE.				
1	8	10¾	.....	.....		290	6¾	21	41½	
2	15	5½	.....	.....		.....	12	.....	.....	
3	17	5½	94½	1		.....	out	.....	.....	
4	12	.....	22	.....		.....	.....	84	.....	
5	22	1½	65	2¼		188	3½	45	20	
6	8	.....	49½	.....		66	.....	28	12½	24.3
						BURGUNDY MIXTURE.				
7	11	9¼	35½	1⅜		128	5½	49	13½	
8	21	.....	64½	.....		246	.....	35½	31	
9	17	10¾	52½	2		323	2	68	23	
10	11	.....	43	.....		.....	.....	.....	.....	
11	6	2	14½	2½		69	¼	37	10	
12	20	.....	41	3	2	188	.....	18	41	23.6
CHECK (UNSPRAYED).						CHECK (UNSPRAYED).				
13	15	1	19	5		89	9	38	11½	
14	13	2½	17	4½		.....	6¾	18	.....	
15	19	3½	13½	7½		67	¾	11	25	
16	17	3½	16½	5½		.....	4	13½	.....	
17	10	4½	9	5		56	½	13	23+	
18	10	2	9½	6	5.5	45	1½	15	15+	18.5
SELF-BOILED LIME-SULFUR.						SELF-BOILED LIME-SULFUR.				
19	5	.....	10½	3		18	.....	14	7	
20	5	.....	6½	5+		18	.....	11½	8	
21	2	.....	4	3½		15	.....	6½	13	
22	3	.....	12	1⅜		49	.....	7	30	
23	3	.....	10½	2		30	.....	.....	.....	
24	2	.....	5	3		13	.....	18½	5	
25	4	.....	3	8		8	.....	10	5	
26	2	.....	5½	3		26	.....	8	17	
27	4	.....	7½	3⅜		36	.....	16	13	
28	7	.....	11½	4		33	.....	11½	16	
29	2	.....	5½	3		10	.....	5½	8	
30	5	.....	10	3+	3.5	19	.....	5	20	12.9
COMMERCIAL LIME-SULFUR.						COMMERCIAL LIME-SULFUR.				
31	8	.....	5½	8+		23	.....	11½	11+	
32	0	.....	26	0		119	.....	12	40	
33	3	.....	11	2—		34	.....	6½	25	
34	6	.....	12	3+		49	.....	18	14+	
35	5	.....	13	3—		39	.....	11	17.7	
36	1	.....	9½	7		50	.....	13½	19½	
37	10	.....	10	6.6		44	.....	8½	26	
38	10	.....	14	5—		69	.....	9½	30+	
39	4	.....	7½	3½		29	.....	3	40	
40	8	.....	9½	5		40	.....	14	16	
41	5	.....	14½	2+		55	.....	4	47+	
42	18	.....	12½	8	3.9	46	.....	15	16⅔	25.2

reduced 2% on the Bordeaux plot; 5½% on the check; 3½% on the self-boiled lime-sulfur, and 3.9% on the commercial lime-sulfur. Again, during the more serious outbreak early in August the loss was 24.3% on the Bordeaux plot; 23.6% on the Burgundy; 18.5% on the check; 12.9% on the self-boiled lime-sulfur; 25.2% on the commercial lime-sulfur.

From the earlier record it would seem that all three mixtures have been a benefit, with the best showing for the Bordeaux. The second record, however, shows a greater loss in all cases except self-boiled lime-sulfur, when compared with the check.

The poor showing made by the sprayed plots in the second check may be partly explained by the fact that the second period of infection did not occur for nearly a month after the second application of spray was made. This would give ample opportunity for new sources of infection to break out. Moreover, as none of the spray used adhered well to the green fruit, it was not properly protected from infection.

In 1914 the work was extended at the beginning to take in three other orchards; namely, those of Mr. W. I. Johns, at Myrtle Creek, Mr. H. M. Birdsell at Salem, and Mr. Robert Johnson at Corvallis, in addition to the Newberg orchard used in 1913. When it was found that very little fruit was set in these orchards, only the first application was made. This was the case with the Newberg, Salem, and Corvallis experiments. The one started at Myrtle Creek, where a plot of Petites, bearing a fair crop, was included, was continued through the second spray and a further check made at the close of the season. In this experiment Bordeaux mixture and Atomic sulfur were used, the first spray being applied after the blossoms had been out full for about ten days. Some blossom blight was observed at this time, but much more was seen in other orchards during the week or more following.

An outbreak of fruit rot occurred in the vicinity of Myrtle Creek and Riddle some time about May 20. At this time Prof. W. S. Brown and Mr. Johns made careful observations in the experimental plot, the conclusion being that the Bordeaux plots had suffered less than the check, the unsprayed part of the orchard, or the Atomic sulfur plot. This difference was not noticeable when the orchard was again visited on June 8, since there had been considerable drop due to other causes.

A second application of the spray was put on during the last week in May, but this seemed to have little or no effect, inasmuch as the rot did not spread after the one period of infection, except in cases where rotting prunes were in contact with healthy ones. There was no period of general infection at this place at any time later in the season, so that the results obtained in this experiment were of doubtful or little value.

The Newberg experiment having been discontinued after the first application, arrangements were made at Springbrook to spray both Petites and Italians with Bordeaux and Atomic sulfur, in an orchard where there had previously been much trouble from brown rot and where we had collected twig blight of prunes and cherries due to this fungus. No early application was made in this orchard and up to the time of our first spray no fruit rot had appeared. The first spray was applied on June 23, at a time when weather conditions favored an outbreak of the disease. No disease appeared, however, and up to the time of prune harvest it had been difficult to find brown rot in the orchard. An attempt was made to compare the sprayed plots and checks on August 27, while the Petites were being picked, but there was so little rot at this time that no difference could be detected. Some trees that had not been sprayed were absolutely free and on others one could find very few clusters of diseased fruit. The same condition held for the sprayed plot. Consequently, the results here were of no value so far as the experiment under consideration is concerned.

One further experiment was made at Dundee in the Italian prune orchard of the Dundee Fruit and Walnut Co. In this case a late application of Bordeaux mixture was made on about twenty trees in an attempt to prevent the outbreak of brown rot that frequently takes place at harvest time. No results of this experiment were obtained owing to the fact that almost no rot appeared in the orchard.

It is seen from the above outline of spraying experiments that very little has been accomplished that will enable us to make recommendations. It seems probable that Bordeaux mixture is as satisfactory as any spray that has

been tried, and that the time for the application varies with conditions that are not clearly understood. In the test that has been made of the different spray materials, it is evident that commercial lime-sulfur is not safe to use on prunes in foliage, since injury resulted when it was used in a 1–40 dilution. Self-boiled lime-sulfur and atomic sulfur are worthy of further trials, although both of these sprays develop the best efficiency under a higher temperature than prevails in the sections of the State where this trouble is prevalent.

It is evident from our observations that outbreaks of brown rot are likely to occur at any time during the season, and that when an outbreak does occur the greater part of the infection takes place during a short space of time.

NOTES ON MISCELLANEOUS POTATO DISEASES.

By F. D. BAILEY.

The report for 1911 and 1912[3] presented a discussion of the more common diseases of the potato that occur in Oregon, with the recommendations that were being made at that time. Since then the writer has continued his studies and observations of potato diseases, both in the field and in storage. Results of other investigators that have been published in the meantime, moreover, make it desirable to supplement and extend information. It is with this end in view that the following miscellaneous notes are submitted.

FUSARIUM WILT AND STORAGE ROTS.

Recent investigations conducted by Wollenweber make necessary the further differentiation of the organisms concerned with the disease previously called Dry Rot or Wilt. Instead of one specific fungus, several different organisms which have been confused in previous studies of this trouble are found to be the causal organisms. It has been proved now that *Fusarium oxysporum* (Schlecht) Smith and Sw. is the cause of a wilt disease of potatoes, but does not produce the rot of tubers in storage.

Fusarium Wilt.

This disease is already widespread in the United States and in some districts is causing most serious losses. The damage, in this case, is done entirely in the field. The causal organism is closely related to the fungi that cause wilt of cotton, watermelon, and cowpea, which are largely confined to districts where the soil is of a sandy nature. This, however, does not seem to be necessarily the case with the potato wilt form, although it becomes more serious in dry seasons. Orton states[4] that "in Oregon, Utah, and Colorado wilt occurs on heavier soils, varying from sandy loam to clay loam. It appears that wilt is more likely to develop in any such good potato soils than under conditions unfavorable to the crop." The belt of greatest destruction by this fungus falls across the United States at the southern boundary of extensive potato culture, through Ohio, Nebraska, Colorado, and California. In California very serious losses have been caused in the delta district of the San Joaquin valley. Here potatoes are the best money crop, and consequently have been used until the growers, who in most cases are not the land owners, have been driven to a short rotation only, because their potato yield has been cut far below a normal yield, in many cases even less than 50%. This wilt fungus is the principal factor responsible for this loss, according to Orton[5]. Referring to Orton[4] again, we find him saying: "One of the leading potato districts north of California is the Willamette Valley, in Oregon. Here wilt is present to a serious extent. During visits in 1909 and 1910 the writer saw fields liberally dotted with yellow and dying plants. This valley furnishes most of the seed potatoes brought into California, and inspection of such potatoes has revealed much stem-end browning."

There is no doubt that this disease has become widely distributed in Oregon, and even though the loss is not appalling as far as the yield is concerned, we find that seed produced in our region carries the fungus to a sufficient extent to bring about serious losses farther south. This condition is becoming more severe where potatoes are the main crop, and the soil, together with the cull potatoes that remain in it, form a desirable medium for the maintenance of the fungus. There is little wonder, then, that Oregon is gradually losing a valuable market for a considerable quantity of potatoes. For this reason,

[3]Bailey, F. D., Diseases of vegetable crops. Potato Diseases. Biennial Crop Pest and Horticultural Report, 1:277–288. 1913.

[4]Orton, W. A. Potato wilt, leaf-roll, and related diseases. U. S. Dept. of Agr., B. P. I. Bull. 64. (Professional Paper), p. 1–48. Feb. 10, 1914.

[5]Orton, W. A. Potato diseases in San Joaquin County, California. U. S. Dept. of Agr., B. P. I. Circ. 23, 14 p. 1909.

as well as for the purpose of reducing the effect of the disease in his own fields, the Oregon grower should make special effort to acquaint himself with this and other diseases of the potato, as well as the best methods that are known to control them.

Control. Healthy seed is one of the most important points to be considered. The tuber-unit method or hill-selection method[6], supplemented by careful inspection of tubers for the stem-end browning or discoloration, and formalin or mercuric-chloride treatment, will insure the grower against introduction of wilt into new soil or disease-free soil; but where soil has been cropped to potatoes without these precautions, the fungus may already be present, and when once infested, the soil cannot be cleaned up without resorting to a 5- to 8-year period of rotation.

A rotation with barley has been found more satisfactory for the reduction of wilt than other crops. Oats and corn are also recommended for the delta region of the San Joaquin River, California.

Storage Rots.

The species of the genus Fusarium that are concerned with the tuber rots are in most cases wound parasites and are not responsible for the leaf curl or wilting of the foliage or any disorder of the tops. Observations indicate that they may, when present in the seed tuber, kill the germ or sprout and in this way greatly reduce the stand, but the far more serious loss from this source is the decay of the tubers while in storage or transit.

Of the half dozen or more species of Fusaria frequently found associated with decay of potato tubers, there are at least three that are of considerable economic importance in Oregon. These are classed according to more or less characteristic symptoms, as the Powdery dry rot, *F. trichothecioides*, Wollen., Dry rot *F. coeruleum* (Lib), Sacc, and Jelly-end, *F. orthoceras*, App. and Wr. While these characters do not always occur in a clearly defined manner so that a determination can be made by a glance at the diseased specimen, yet there are characteristic differences in the causal fungi, which may be determined by a careful study of the organisms in pure culture.

Powdery Dry Rot. This disease is one that has only recently been studied sufficiently to separate it from other storage rots. The causal organism was named in 1912 as a result of studies on specimens from Spokane, Wash., in 1910, by Wollenweber[7], and has since been found common in the Middle West[8-9], and Northwest. It has not been reported to occur in the Eastern States or in any country other than the United States, and is apparently restricted to the dry and irrigated sections of the great plains and Inland Empire. In Oregon, several specimens from different localities have yielded this fungus as a result of cultural studies (Fig. 20), but never has it been found in tubers from the western part of the State.

Several instances are known where the Powdery dry rot has caused heavy loss of tubers while in winter storage or in transit. In some cases carloads that started from northwestern points in apparent good condition had to be destroyed at Chicago or Texas points because of the rapid spread of this rot.

The fungus causing Powdery dry rot is not able to attack the growing plant to any extent, but in case the seed is affected the fungus continues to live in the seed tuber and in the soil, spreading to the new crop where any bruise or wound on the surface of the new tubers enables it to gain an entrance. Decay may or may not begin at once, but once conditions become favorable it will spread rapidly in the tuber in which the bruise started, and to other tubers, generally through some wound or through old stem scars; but it may spread

[6]Stuart, William. Good seed potatoes and how to produce them. U. S. Dept. Agri. Farmers' Bull. 533., p. 1–16, April, 1913.

[7]Jamieson, Clara O. and Wollenweber, H. W. An external dry rot of potato tubers caused by *Fusarium trichothecioides*, Wollenw. Journal, Washington Academy of Sciences, v. 2, no. 6, p. 146–152. 1912.

[8]Orton, W. A. Potato-tuber diseases. U. S. Dep. of Agri., Farmers' Bull. 544, 16 p. 16, fig. 913.

[9]Wilcox, E. Mead, Link, G. K. K. and Pool, V. W. A dry rot of the Irish potato tuber. Neb. Agri. Exp. Sta. Research Bull. No. 1 and Bull. No. 134, Mar., 1913.

Fig. 20. The fungus that causes powdery dry rot growing out in pure culture on nutrient agar from diseased bits of tuber.

to uninjured tubers with which the diseased tuber may be in contact. The centers of infection shrink, and as decay advances, wrinkles of the skin form in more or less concentric rings about the center of infection, the whole area becoming a darker brown in color than the normal. (Fig 21). On cutting through a decayed spot, the center is found to be dry and powdery, due to the abundance of fungus mycelium, spores, and starch grains, and as the decay progresses internal cavities are often formd. The border or advancing region of the decay is deep brown in color. As decay advances, cracks are sometimes formed over the surface through which a dense pinkish-white growth of the fungus appears. On examination, this fungus growth is found to be composed of vast numbers of spores and the spore-bearing stalks or conidiophores.

Control. At present it is only possible to offer a few suggestions directed toward the control of this disease.

Since the fungus is carried in the seed, it is very important that no diseased seed be planted. A most careful inspection should be practiced and any discolored or decaying tubers discarded. This should be supplemented with the formalin treatment after cutting.

The fungus is able to live for some time in soil, consequently it will be necessary to practice rotation after this disease becomes prevalent. A five-

Fig. 21. Powdery dry rot decay of potato tubers.

year rotation or longer is recommended to be tried where this trouble has become established. It is not known to attack any other host.

The greatest difficulty comes in so handling potatoes in storage that loss may be reduced to a minimum. Often potatoes, after digging, are placed under poor storage conditions, where they are subjected to severe changes in temperature and where very poor ventilation is provided. Under such conditions several of these decay organisms find a most advantageous opportunity for growth. It becomes more necessary, then, to have well-constructed storage cellars where a low, constant temperature can be maintained and provided with proper ventilation. It is important, first, to exercise extreme care in handling so as to prevent bruising, and, second, to give careful attention to each tuber, even to the extent of hand sorting, to prevent the spread of the rot, if it starts to develop. If these precautions are taken, the disease may be greatly reduced.

It is advisable to cook or burn all decaying potatoes or refuse about the storage cellar and to spray or wash the walls with 1% copper sulfate, or 1 to 1,000 solution of mercuric chloride before the new crop is brought in.

When the potatoes are in transit, the temperature and ventilation of the cars is fully as important as in the storage house, and more attention to these points would greatly reduce the losses that are frequently experienced.

Dry Rot. The organism causing this particular type of storage rot has been determined tentatively as *Fusarium coeruleum* (Lib.) Sacc.[10] The trouble

[10]Appel, Otto and Wollenweber, H. W. Grundlagen einer Monographie der Gattung *Fusarium* (Link). Arbeiten, Kaiserliche Biologische Anstalt fur Land, und Fortswirtschaft (Germany) Bd. 8, Heft. 1, p. 1–207, 12 fig. 3 pl.

has appeared in several instances where the potatoes were held in storage under adverse conditions. In the western part of the State, especially near the coast, it frequently happens that the tubers do not properly mature in time to be dug before rainy weather sets in. In this case they are dug as soon as opportunity permits and may go into storage in a premature condition or when wet. Injury at this time due to rough handling opens the way for the decay-producing organism, and as the fungus causing this type of rot is constantly present in the soil on decaying vegetation of all sorts, every chance is given for infection. Even under these conditions the abundance of the decay depends primarily on the humidity and temperature of storage houses.

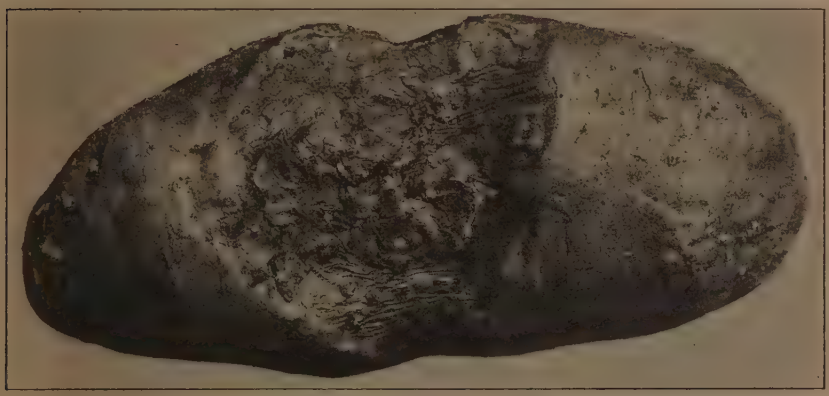


Fig. 22. Type of dry storage rot common in the western part of Oregon.

The decay produced by this organism (Fig. 22) differs from the powdery dry rot in that it is not powdery in texture, and when the fungus mycelium breaks out on the surface it often develops a bluish tint instead of the pink so characteristic of *F. trichothecioides*. As the decay due to this fungus progresses, it is often complicated by the association of various other soil organisms, both bacteria and saprophytic fungi. By making inoculations with pure cultures of the fungus into normal tubers that have been previously sterilized by soaking in mercuric-chloride solution, the decay can be reproduced.

That tubers partly decayed by this rot are not fit for seed, was demonstrated in one instance that came to the writer's attention. The grower ran out of clean, healthy seed and undertook to cut seed pieces from potatoes that were partly decayed. He cut away the discolored flesh, and after cutting used the formaldehyde treatment. Where this seed was used the stand was greatly reduced as compared to the stand in the adjoining row where healthy, treated seed had been used.

Control. In general, the control measures discussed above for the Powdery dry rot will answer for this disease as well.

It is also worthy of mention that crates holding about 50 lbs. are very satisfactory for handling the crop (Fig. 23). In the first place, the tubers can be handled with much less bruising, and in the second place, small bins can be built up of the filled crate in such a way in the storage house that much better ventilation is provided.

Jelly-end. A third type of rot is that frequently referred to as "jelly-end," and may be due to the species *Fusarium orthoceras* App. & Wr. This organism is placed in the section Elegans with *F. oxysporum*, the potato wilt species, by Wollenweber[11], and he states that it "inhabits the root

[11]Wollenweber, H. W. Studies on Fusarium problem. Phytopathology, v. 3, no. 1, p. 24–50, fig. 1, pl. 5. Feb, 1913.

system and tubers of Solanaceae." It is the "probable cause of jelly-end rot of potato tubers."

This is the disease that was formerly confused by Smith and Swingle[12]

Fig. 23. Tubers handled in the type of crate here shown are not bruised and injured as much as when bags are used.

with the wilt disease, where decay of the tuber starts at the stem end. The characteristic jelly-end does not develop as a rot spreading from the vessels, although this may be the case, especially if the fungus causing rot and the one producing wilt are both present.

The jelly-end as observed in Oregon develops before the tubers are dug, and more frequently is found where digging is delayed until late in the season or until spring. A soft rot is produced, and the consistency of the decayed portion is somewhat suggestive of jelly; wherefore the name. After digging, if the tubers have a chance to dry, the decay is checked and soon shrinks so as to resemble the effect produced by dry rot.

Miscellaneous Fungous Diseases.

Several other troubles have been observed during the last two years in the Northwest, but are not as yet causing serious losses in Oregon. These are briefly reported at this time in order that growers may be acquainted with them and guard against their distribution or introduction.

It should be understood, then, that because a disease has not proved serious up to the present time, this is not necessarily an indication that it may not break out in epidemic form later. Where prevention is a comparatively simple matter it is obviously unwise to allow such diseases to become widespread.

Silver Scurf. This is a disease of the tubers which has seldom attracted the attention of growers, although it seems to be widely distributed[13]

[12]Smith, Erwin F., and Swingle, D. B. The dry rot of potatoes due to *Fusarium oxysporum*. U. S. Dept. of Agr., B. P. I., Bull. 55, 64 p., 8 pl., 1904.

[13]Melhus, I. E. Silver scurf, a disease of the potato. U. S. Dept. Agr. B. P. I. Circ. 127. 15–25. May, 1913.

throughout the country. The fungus causing the trouble is known as *Spondylocladium atrovirens* Harz. The principal loss is due to deterioration in storage and in loss of vitality of the tubers for seed purposes. This is brought about through the fact that the fungus lives in the outer cells of the tubers, which it injures to such an extent that more water is transpired than is the case in normal potatoes. As a consequence, the potatoes shrink and the surface becomes wrinkled. The common name of the disease relates to the appearance produced before the surface becomes wrinkled. At this time the affected spots or areas present a decided silvery appearance which is very noticeable on clean, smooth-skinned varieties. (Fig. 24.) If such tubers are allowed to stand in a humid atmosphere away from the light, in a short time a sparse, blackish, moldlike growth appears which would be found on closer examination to consist of upright stalks, on the upper portion of which several septate, brown spores are borne in whorls. In a short time after infection and as the fungus spreads through the surface cells, minute black sclerotia or resting bodies are formed, which may later be sloughed off with the surface cells. In this way the fungus gets into the soil in a condition to withstand unfavorable circumstances, and it is also transferred on the sound seed potatoes and in this way may become scattered throughout the potato-growing sections.

Fig. 24. Tubers showing early stages of silver scurf infection.

Experiments that have been conducted indicate that no seed treatment is effective against this disease. As a precautionary measure it is advisable to use seed that is free from the disease and plant on soil that is known not to have produced a diseased crop.

Early Blight. From observations made during the past four seasons in various potato-growing sections, it is evident that this foliage disease of potatoes rarely occurs in this State. In no instance has it been observed in sufficient amount to cause appreciable damage. Whether this is due to the fact that it is not widely distributed or because of some unfavorable condition for its development is not known.

The fact that early blight has recently been found, however, and that it may become more abundant, makes it advisable to give a brief description of the disease.

The fungus causing early blight is very different from the one causing the destructive late blight. While it is a true parasite, it attacks only the foliage and does not spread as extensively or rapidly as does the late blight. The affected spots are brown and circular and show quite decided concentric

markings. Several spots may converge, eventually killing an entire leaf. Losses as high as 50% have been attributed to this trouble in the eastern United States. The attack frequently begins early, about the time the plants come into blossom, and may continue throughout the season unless checked by severe drought or spray.

Tomatoes and jimson weed are also said to be attacked by the fungus.

Control. It has been found that spraying with Bordeaux mixture, the same treatment that is used for late blight, is a very efficient means of control.

Verticillium Wilt. Another wilt disease[2] commonly found in the northern districts where potatoes are grown, is caused by the fungus *Verticillium albo-atrum* Reinke & Berth. While this disease has been present in both Europe and America for many years, it has not been the subject of investigation as frequently as some of the other diseases, owing to the fact that it has never become epidemic and only kills scattering plants through the field. This fungus produces symptoms quite similar to the Fusarium wilt, and in fact need not be differentiated for treatment by the grower, since the same recommendations apply to both.

Characteristic symptoms of this disease are a sudden wilting and premature death of the plant, with or without yellowing of the foliage. The vascular system of the stem becomes discolored and may be found to contain abundant mycelium of the fungus throughout. This breaks through the surface, even before the complete death of the plant, where abundant spore production takes place, giving to the entire top a grayish, smoky appearance that distinguishes this trouble from other diseases.

The tubers show a discoloration of the vessels at and extending back from the stem end. This discoloration is blacker and more pronounced than is the usual case with a similar trouble due to species of Fusarium.

Control. The control measures of this disease are the same as for the Fusarium wilt described on page 246.

Mushroom Root-rot. The mushroom root-rot disease, which is known to attack many plants, including nearly all fruit trees and many of our native shade and forest trees, has been found attacking potatoes, in one instance near Vancouver, Wash., and one instance at Hood River, Ore. Mr. H. P. Barss saw the specimens at Hood River in the summer of 1913. The occurrence of this fungus, *Armillaria mellea* Vahl., has been previously published in Australia, but it has not been reported in this country prior to its occurrence in Washington, which has been previously reported in Phytopathology by the writer.[14]

This disease produced on potatoes was not serious, but the tubers evidently became infected through growing in soil which contained old roots on which the rhizomorphs of the fungus were growing. Under such conditions it is likely to occur in this State, and might prove to be of economic importance. Mention of the trouble is therefore included here, so that Oregon growers may be advised to be on the lookout for it and to report its occurrence.

The rot produced by this fungus is quite different in character from any other tuber decay. The rhizomorphs or shoe-string-like strands of the fungus are generally found on the surface and from these strands a development of mycelium takes place that penetrates the surface and extends into the tuber. (Fig. 25). This mycelium forms white sheets or layers that are quite compact and very similar to the growth of Armillaria, as it spreads out through the cambium between the bark and wood at the crown of a tree. Within the potato no such large sheets are found as may be found in diseased trees. Should this disease be found at any time, the writer would be glad to have specimens for further investigation. Should it occur abundantly, remedial measures can probably be suggested.

Rhizoctonia violacea. On December 30, 1913, two specimens of potatoes affected with a disease not heretofore described in the plant disease literature of this country, were received from Laurel, Oregon.

The grower who sent us the specimens stated at the time that the trouble

[14]Bailey, F. D. Notes on potato diseases from the Northwest. Phytopathology V., no. 4, 321–322, pl. 20. Ag. 1914.

Fig. 25. Mushroom root rot attacking tubers. The decay has started at several points where the rhizomorphs are attached to the surface.

seemed to be new to his part of the country, but no further information concerning the extent of loss, etc., was obtained, and we were unable to secure more specimens on further inquiry.

This disease may be of considerable importance, inasmuch as the fungus associated with it closely resembles *Rhizoctonia violacea* Tul. of Europe.

The characteristics of this disease as it appeared on specimens received were as follows: The surface was almost entirely covered with a dense felt-like mat of a chocolate color when dry, violet-brown when moist. This mat was found to be composed of mycelium which had long narrow cells and a branching habit characteristic of Rhizoctonia. The greater part of this mycelial mat could be easily removed, and beneath this the surface of the tuber was covered with very small dark spots. These spots appeared to the unaided eye as minute eruptions of the skin. Under the microscope one can see the mycelial threads attached at these points, and a freehand section through such a spot shows it to be a structure composed entirely of interwoven fungus threads forming a sclerotium. No evidence of differentiation or any type of spore formation within this body could be found on examination of many sections. The portion of the sclerotium near the surface is composed of cells that are very deeply colored, giving the black appearance. The outer surface of the sclerotium is seen to project above the surface, while the lower or underlying portion is imbedded in the outer cortical layers of cells of the tuber. Furthermore, there is a strand of fungus tissue extending deeper than the sclerotium, which connects it with a layer of the same type of fungus tissue spreading

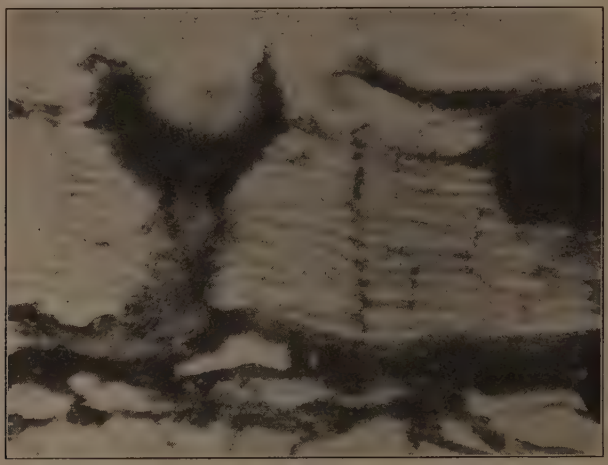


Fig. 26. Microphotograph 120x. Section through a microsclerotium of R. violacea.

between the cortex and parenchyma from the point where this strand reaches the parenchyma.

A microphotograph, Fig. 26, illustrates this condition and would seem to indicate that the fungus has pushed its way in from the surface, since the cell walls of the cortex have been bent downward where in contact with this fungous strand. The sclerotium shown is not complete at the top, having been broken in sectioning.

Attempts to grow this fungus in culture failed. This has been the experience reported in attempts to grow *R. violacea*.

No material of *R. violacea* Tul. has been available for comparison, but the description given in Massee [15] and the account and figures in Prillieux [16] are so

[15]Massee, George. Diseases of cultivated plants and trees. p. 236-239. 1910.
[16]Prillieux, Ed. Maladies des plantes agricoles. p. 144-157. 6 figs. 1895.

characteristic of this disease and so different from any other known on potato tubers that the writer believes he is justified in calling attention to the probable occurrence of *Rhizoctonia violacea* Tul. in America.

NON-PARASITIC POTATO DISEASES.

In addition to the already long list of fungous and bacterial diseases common to the potato, there is one class of disorders that is thought not to be due to any parasite. These disorders are none the less important for that reason, however, and when one attempts to follow the European literature on potato diseases he finds more material on the one subject of "leaf-roll" or "Blattrollkrankheit" than all other diseases. The trouble has been so much of a puzzle that many theories have been advanced to explain the disease. Some facts of value have been established. While the greatest losses from this disease have been experienced in Europe, we have one memorable example in our own country—namely, the outbreak in the Greeley district of Colorado and in western Nebraska, which occurred in the years 1911 and 1912 when the output of these districts was reduced to as low as 3% to 10% of the normal.

Typical leaf-roll has not been found in Oregon, although plants that show some of the symptoms are occasionally seen. These symptoms can generally be traced to some other cause, frequently to some of the diseases that we are familiar with or to mechanical injury of the stem.

Curly Dwarf. A disease that is classed with the leaf-roll, and one that, like leaf-roll, is also of unknown cause but quite distinct in character, is frequently found in this State. This is the Curly Dwarf, or "Krauselkrankheit" of the German writers. The name indicates the characteristic appearance of diseased plants. The growth is much stunted. The foliage, while usually normal in color, presents a wrinkled and curled appearance that has been compared to Scotch Kale or Savoy cabbage (Fig. 27) This condition is brought about by the shortening of all of the stems and vines, or, more properly, a shortening of the vascular tissue. The trouble may appear only in scattering hills throughout a field, or, more rarely, it may be general. The field illustra-

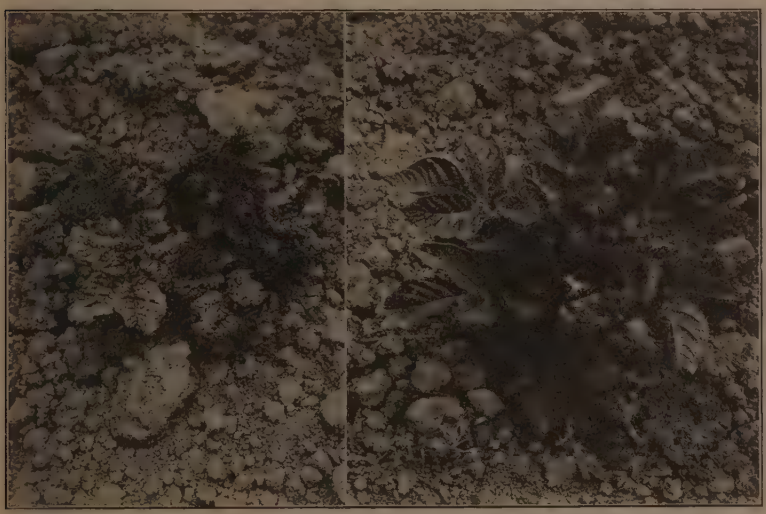


Fig. 27. A curly dwarf plant on the left. Normal plant of same age on right.

tion (Fig 28) shows a rather extreme case of this type, where the stand was poor because of poor germination, and where the plants that did come up were in many cases affected with curly dwarf. This condition is very likely to be the case if seeds from curly-dwarf plants is planted the following year. It is considered that curly dwarf is the result of weakness or deterioration of the stock, since it is inheritable but not communicable. A strain once affected apparently cannot be rejuvenated, and frequently the disease shows up suddenly in a strain that had hitherto been apparently healthy. This weakness makes itself apparent in the yield, since badly affected hills rarely produce tubers of marketable size.

From the information available at present on this disease, it is evident that it is one that growers can ill afford to overlook. If only scattering hills appear in a field, it is advisable to pull these during the early part of the season to avoid any possibility of getting tubers from such hills into the seed for future use. If a considerable number of hills are found, it will be advisable to secure seed from another source, known to be free from curly dwarf.

Internal Browning of Tubers. The internal browning or brown spot of tubers is another disease of non-parasitic origin. It may be easily distinguished from the discoloration caused by the wilt organisms or from the various rots when one once becomes familiar with it. The affected tubers seldom show any indication of the trouble from the exterior; and on cutting them, one finds the irregular brown spots, more frequently near the center of the tuber and with no apparent connection with the surface at any point. The spots vary in size up to ½ inch in diameter, sometimes many of them seeming to overlap in places so that the greater part of the central portion of the tuber is affected. The trouble is not supposed to be transferred in the seed, and is not known to affect the yield. A few specimens found in a carload, however, are sufficient to spoil the sale of the entire lot; since the disease cannot be detected without cutting, and the market does not take chances with potatoes of doubtful table value. Its occurrence is thought to depend on certain soil and climatic conditions. Lack of water at some period of growth and depth of planting are two factors of importance. It has been found to occur in tubers that are formed close to the surface of the soil, whereas those at a greater depth were not seriously affected.

Fig. 28. Field in which a high percentage of plants were affected with curly dwarf.

POTATO SPRAYING EXPERIMENTS.

By F. D. BAILEY.

In view of the fact that potato late blight is known to occur frequently in the coast region wherever potatoes are grown and occasionally becomes a serious menace to the late crop in other sections of the State west of the Cascades, as was the case in 1912, it has been deemed advisable to conduct spraying experiments to determine whether or not this disease can be controlled as satisfactorily here as in a number of the Eastern states. In view of the results of Mr. Cates' experiment, which is recorded in detail below, and similar results reported from eastern stations, it was considered desirable to determine how consistently the yield could be increased by spray in case blight did not appear. Experiments started some years ago were dropped before the close of the season, because the investigator left the employ of the Station and no one was engaged to continue the work. No other attempts have been made in Oregon, to the writer's knowledge, where careful check plots and records of results have been kept to show whether or not it pays to spray potatoes, with the exception of the following experiment:

In 1909 Mr. C. C. Cate arranged to conduct a spraying experiment at Brownsville, Oregon, to determine the effect of Bordeaux mixture and arsenate of lead on the yield of potatoes. Since it has been so well established in the eastern part of the country that spraying will increase the yield even where no blight is present, under conditions quite similar to those of the Willamette Valley, it was thought that similar results might be looked for here.

Mr. Cate made three applications of spray. On May 31 he used 6-6-50 Bordeaux with 2 lbs. of arsenate of lead in each 50 gallons of spray; on June 12 he used 4-4-50 Bordeaux with the same amount of arsenate; and on July 2 he used 4-5-50 Bordeaux with the same amount of arsenate, the arsenate being added to control flea beetles. He states that later sprayings were not made, as the rows were so close together that the vines would be crushed by the wheels of the sprayer. The chief injury seemed to be due to flea beetles, since no blight was present.

The following very striking results were reported:

Check (unsprayed) plats yielded 270 bushels to the acre.
Sprayed " " 390 " " "
The increase in yield due to spraying was 44.4%.

For the result of a test that was made in 1901 at the Puyallup Station, Western Washington, reference is given to Bull. No. 46, Wash, State Agric. College.

Potato Spraying Experiments for 1913.

The place selected for the experiment was in the delta reclamation tract at the mouth of the Clatskanie River. This extensive marshy tideland has been reclaimed by dyking and much of it was under the plow for the second time and planted to potatoes for the first time in 1913. Where potatoes had been raised in this section in 1912 they suffered badly from the blight. The growers were anxious not to repeat the experience and were willing to try the experimental spraying on an extensive scale in several cases. Arrangements were made with Mr. John Cheldelin to spray as directed throughout the season, using his entire sixteen-acre field. Mr. Joe Miller had also determined to spray and was guided somewhat in his operations by the writer. These experiments will be written up separately with the results in each case.

The Cheldelin Experiment, 1913.

In this experiment the four applications of spray were made on July 11, August 7, 26, and September 11. Bordeaux mixture was used in the 4-4-50 strength for the first and second spray and in the 6-6-50 strength for the two remaining applications.

Table I gives the results obtained, drawing the comparison between the

sprayed row and the unsprayed row next to it. Since each row covered approximately one-eighth of an acre, the deduction has been made on this basis:

Table 1. Comparative Yield of Sprayed and Unsprayed Potatoes.

Sprayed—Marketable.		Unsprayed.		
		Marketable.	Blighted.	Loss in yield
A row	28 sacks	25 sacks.	2 sacks.	1 sack.
An acre	224 sacks	200 sacks.	16 sacks.	8 sacks.

These figures show an increase of 24 sacks an acre, or approximately 46 bushels in favor of the sprayed plot.

The above estimate is based on figures taken at the time of digging. There was further loss in storage, and since quite a few blighted tubers were unavoidably placed in storage with the lot from the unsprayed plot, it is very probable that a part of this loss was due to blight from this source. Reference to the Miller experiment shows that loss in storage was greater in the potatoes from the unsprayed plot than from the plot where blight was controlled by spraying.

The following table gives the total cost of the experiment for the season:

Cost of Materials—Bluestone, 500 lbs., at 8 cents			$40.00
Lime, 3 bbls., at $2.00			6.00
Piping and pump			4.35
Freight			1.20
			$51.55
Cost of Labor....4 applications, 2 men and team, 2 days for each application, man and team, at		$5.00	
Man, at		2.50	60.00
Total cost of spraying			$111.55
Total cost an acre			6.96

A Hurst sprayer, belonging to a neighbor, was borrowed for the work, consequently this item has been omitted from the cost.

It is easily seen that if 46 bushels may be saved to the acre at a total cost of $6.96, it pays to spray.

The Miller Experiment, 1913.

Mr. Miller used the same strengths of Bordeaux mixture as those used by Mr. Cheldelin, and the dates for the first and second spray were the same. The third application was made on August 21, but at this time only two-thirds of the field was covered, owing to an accident to the spray outfit. The fourth application was omitted.

Blight appeared early, soon after the middle of September, and destroyed the tops of the six check rows and, 16 days later, the third of the field that did not receive the third application. One could tell exactly where, in the row, the accident to the sprayer had occurred by the appearance of the tops. The sprayed tops, since they were protected from infection, continued to grow for approximately a month, before the potatoes were dug.

The unsprayed plot of six rows yielded 64 sacks less than the six rows adjoining, where three applications of spray were made. Since five rows made one acre in this field, as it was laid out, the total saving in yield was approximately 103 bushels an acre. This, however, is not all. Mr. Miller had to pay diggers 12½ cents for digging the unsprayed plot, as compared with 9 cents for the sprayed plot, on account of the increased labor of sorting the unsprayed potatoes, since a great many more culls were present, many of which were rotted or partly rotted by tuber infection of the blight fungus. His loss in storage from rot, however, amounted to from one-fourth to one-third more in the potatoes from the unsprayed plot.

Potato Spraying for 1914.

During the season of 1914 potato spraying was again taken up at Clatskanie on the same place as during the season preceding. The cooperative work was carried on as before with Mr. Nyquist on Mr. Cheldelin's place.

For this work the firm of R. M. Wade of Portland kindly loaned us the use of a two-horse Iron Age Traction Sprayer, which was used throughout the season. A special low nozzle attachment was added, which was so adjusted that the spray was driven over the tops from above and from low down on either side. This made it possible to cover the foliage in a very satisfactory manner.

It was considered unnecessary to begin the spraying as soon as we did in 1913; consequently the first application was not made until August 15. With everything in readiness and working smoothly, we were able to cover the entire field of sixteen acres in one day, with the exception of the three rows that were kept out as checks and several areas where the tops had been destroyed by cutworms two weeks earlier. The growth of the tops was somewhat backward at this time, and in some parts of the field there were many plants missing. This was especially true in a section where seed had been used from tubers more or less affected with Fusarium storage rot. Although this rot had been cut away as carefully as possible, and the seed treated after cutting, the stand was markedly reduced where this seed was used.

Fig. 29. Three rows in foreground were not sprayed and are shown badly blighted. The sprayed field beyond shows very little blight.

Injury due to flea beetles and to Early Blight was very slight, but the cutworms caused rather extensive loss this year.

In this test the 4–4–50 Bordeaux was used for the first application and the 6–6–50 strength for the second and third.

Dates of spraying—Aug. 15, Sept. 2 and 21.

Yield on 3 check rows (unsprayed)	2,750 lbs.
Yield on 3 sprayed rows adjoining	2,550 lbs.
This gave a total loss of	200 lbs.

equivalent to 8.8 bu. an acre.

This loss is difficult to account for, especially when one compares the results with the illustration of the plot taken at the time of digging, showing the unsprayed plot blighted and black to the ground, and the sprayed tops still green and fresh. (Fig. 29.) This contrast was more marked even than the illustration can show, since the color value is lost. Since this unsprayed plot did not show the evident attack of blight until about a week to ten days before digging, it is not surprising that there should be little difference in the yield, but that fact can in no way account for the slightly increased yield in favor of the unsprayed plot. It is possible that there was a sufficient difference in stand due to the work of cutworms to account for it. At any rate, the difference is not beyond the range of experimental error in an experiment of this kind, and we do not believe it is necessary to conclude from this one indication that spraying was responsible for a reduced yield.

At the time of digging, very few tubers were found in the unsprayed plot that showed the blight.

The cost of spraying has been considerably reduced this year, partly through the lower cost of materials and partly because only three applications were made. It runs as follows:

Cost of Materials..	Bluestone, 300 lbs., at 5¾ cents		$17.25
	Lime, 300 lbs		1.75
			$19.00
Cost of Labor.....	3 applications, 2 men and one team, total time 3½ days.		
	Man and team, at $5.00	$17.50	
	Man, at $2.50	8.25	
			$25.75
Total cost			$44.75
Cost an acre for three applications			2.79

Summary.

The result of potato spraying in the Willamette Valley in one instance gave an increase in yield of 44.4% when no late blight was present.

Spraying experiments for two years at Clatskanie show that late blight can be effectively controlled with Bordeaux mixture. In 1913, when blight appeared a month before harvest, the yield was increased 46 bu. an acre in one case and 103 bu. in another.

NOTES, OBSERVATIONS AND MINOR INVESTIGATIONS ON PLANT DISEASES.

By H. S. JACKSON.

The following account is a record of observations and minor or unfinished investigations of various plant diseases which have come to the attention of the department of Botany and Plant Pathology during the past two years. Notes on several diseases are included, not because of their economic importance at present within the State, but because the record extends the distribution, or because the disease has proved to be of importance in other sections of the country, and may under favorable conditions become epidemic in Oregon.

Several diseases are included which are not discussed in the Biennial Report for 1911-1912, but which have since been found to cause considerable damage, and concerning which we have had many inquiries from growers; notably, celery heart rot and stem rot or gray mould of onions.

Several troubles have been partly investigated which seem to be new to science, or at least have not been previously recorded as doing serious damage in America. The most noteworthy are the bacterial spot of peppers, pear canker due to Monilia, and the gooseberry die-back. Investigations will be continued on these troubles as opportunity permits.

In preparing these notes, the writer has drawn freely from notes, observations, and laboratory records of the other members of the staff of the department of Botany and Plant Pathology, who are working under his direction, and to whom grateful acknowledgment is due.

The separate notes here included are arranged alphabetically according to the common name of the host plant.

ALFALFA DOWNY MILDEW.

Peronospora trifoliorum De By.

The downy mildew of alfalfa is found to be a very common fungus in Western Oregon, having been collected several times at Corvallis, and at Salem, Hood River, and other places.

This fungus attacks the tips of the active growth, particularly in the spring. It causes a yellowing of the foliage that is quite noticeable. Where severely affected, the margins of the leaves may be curved downward, and in some cases the writer has seen shoots badly dwarfed by vigorous growths of the fungus over the entire shoot. An examination of the underside of the infected leaves shows the presence of the reproductive stages of this fungus appearing as a gray or violet fuzz over the affected parts.

It is not anticipated that this fungus will become of any great practical importance. It is worthy of notice, however, and might, under conditions ideal for the development of the fungus, cause considerable loss in forage value.

Unfortunately no method of prevention or control has ever been devised, though it is probable that this will not be difficult if the disease ever became serious enough to warrant special treatment.

FIRE BLIGHT OF APPLE, PEAR, ETC.

Bacillus amylovorus Burrill.

This disease continues to be our most important disease of fruits in Oregon. It was particularly severe in the summer of 1913 not only in southern Oregon but also in all sections of the State where the disease is present. In 1914 the trouble was not so generally serious as in 1913. During this year, however, some very important observations were made regarding its distribution. Although no authoritative report of fire blight had been secured in any previous year from Wasco County, there occurred a severe outbreak of the disease in the summer of 1914 in the vicinity of Dufur. The serious importance of its presence in this locality may be appreciated when it is considered that if the trouble

should become established there, conditions would be favorable for its spread to the fruit districts of The Dalles, Mosier and Hood River. Special precautions have been taken by the State Board of Horticulture and their inspectors to prevent the establishment of the disease at this point.

In western Oregon for a number of years fire blight has been known only as far north as the Umpqua Valley. During the summer of 1914 the disease was discovered in the Willamette Valley for the first time at Cottage Grove by Mr. C. E. Stewart, and cankers very similar to if not identical with those of fire blight have also been found at points farther north near Junction City and Alvadore. These facts indicate that fire blight is gradually spreading into all sections of the State where it has not previously been known to occur.

LEAF SPOT OF BEETS.

Cercospora beticola Sacc.

A leaf-spot disease is known to occur in most sections of the country on various types of beets, including the garden beet, as well as sugar beet. In some sections it causes serious losses due to reduction in foliage and the consequent tendency to interfere with root development. Where beets are grown for forage, this disease may cause material loss in forage value.

In Oregon no serious cases have been observed, but affected plants were found by the writer at Brownsville, Oregon, in the fall of 1913. So far as we are aware, this is the first record of the disease in Oregon.

Fig. 30. Leaf of garden beet showing spots caused by Cercospora beticola.

This disease, as the name implies, causes a leaf spot. These spots begin as very small points, nearly white, which rapidly increase in size and assume a brownish color as they enlarge. The margins are usually tinted with reddish or purplish color. (See Fig. 30). Where severe, the spots occur in great numbers, and frequently are so abundant as to make the leaves subject to tearing by the wind or in cultivation. The outer or older leaves are usually attacked first, and the disease is perpetuated from year to year by the dead leaves or fragments thereof falling to the ground and remaining over winter.

The disease is caused by a fungus which develops in the tissues of the spot and produces spores on the surface. If conditions remain favorable for the development of the fungus, these serve to spread the disease throughout the growing season. They also serve to carry the fungus over the winter.

It is found that deep fall plowing, coupled with a carefully planned and thoroughly executed system of crop rotation, is the best remedy, usually controlling the disease satisfactorily. If such methods are not sufficient, it has been found that Bordeaux mixture, 4-4-50, applied first when the very first spots appear and repeated at intervals of two weeks, so long as conditions remain favorable, will entirely control this disease.

It is not anticipated that this disease will become serious in Oregon, since in general our climatic conditions are not favorable for the development of the fungus, but its occurrence is thought worthy of notice.

CELERY HEART ROT.

Bacillus sp.

From time to time during the past four years specimens of a bacterial disease of celery have been received from correspondents, with inquiries concerning the nature of the trouble and requests for control recommendations.

Plants showing the bacterial trouble can rarely be detected in the early stages by any general external symptoms. On close examination, however, brown, watery areas are found on the inner part of the stalks or, in some cases, the leaves of the short central stalks are rapidly breaking down with a slimy, brown decay. This condition spreads rapidly through the heart and thence into the older stalks, where the disease does not present the slimy appearance to such an extent. As it progresses in the older stalks the inner epidermis frequently separates from the mesophyll, giving the surface a blistered appearance. The brown decay does not reach the outside of the stalks rapidly, although a dark discoloration can generally be detected.

Cultural work carried on in 1911 by F. D. Bailey yielded a bacterial organism which appeared constantly on isolation plates from material received from Gaston, Oregon, and material obtained in the local market. Inoculations made with this organism into clean celery stalks by introducing the bacteria growing in pure culture into punctures, resulted in marked decay in one day when the stalks were kept in a humid atmosphere under a bell jar. Several check punctures were made, but no decay resulted. From re-isolations a bacterial organism was obtained that compared favorably with the one used in the inoculations, although a complete physiological study was not made. On further inoculation with this strain, rapid decay resulted as before. The re-isolations proved not to be pure cultures, however, though the organism used in inoculating apparently predominated.

The organisms frequently found associated with the soft rot of vegetables are *B. carotovorous* Jones[15], and four others closely related. All of these differ from the organism causing celery heart rot which we have studied, in that they are not fluorescent, whereas this organism shows fluorescence to a marked degree. This organism also failed to produce soft rot when inoculated into cabbage and carrots.

Clinton[16] has recently reported a bacterial heart rot of celery from Con-

[15]Harding, H. A., and Morse, W. J. The bacterial soft rots of certain vegetables. N. Y. Agr. Exp. Sta. Tech. Bull. 11, 1909.

[16]Clinton, G. P. Celery heart rot. Conn. Agr. Exp. Sta. Rept., 1913–1914, p. 10–12, July, 1914.

necticut that he attributes to *B. carotovorous*, although this has not been established.

Halsted[17] has reported a bacterial decay of celery that he suggests may be due to the same organism which was found causing a high percentage of loss of carrots at the same place.

This would indicate that the Eastern celery rot is in general, due to a soft rot organism of the *B. carotovorous* type, and is therefore not the same as the one under consideration here.

In a recent publication H. Wormald[18] has described a bacterial rot of celery occurring in England, due to an organism that he calls *B. apiovorus* n. sp. His study shows the organism to have points of difference from *B. carotovorous* and the other organisms discussed in Harding's paper, and since he places it with the yellow chromogens it apparently differs from the organism found here.

The disease is probably dependent on abundant moisture, and consequently could be controlled in the field by keeping the centers dry and in storage by proper storage conditions.

Other control measures that suggest themselves are attention to general sanitation and the control of insects, such as slugs, that might be carriers of the decay organisms.

Fig. 31. Leaf of chrysanthemum showing rust sori on under surface.

[17]Halsted, B. D. Some fungus diseases of the celery. N. J. Exp. Sta. Special Bull. Q., p. 10–12, 1892.

[18]Wormald, H. A bacterial rot of celery. Jour. Agric. Science (England), Vol. 6, pt. 2, p. 203–220, 1 plate, May, 1914.

CHRYSANTHEMUM RUST.

Puccinia chrysanthemi Roze.

This rust has been known in America since 1896, appearing first in Massachusetts, from whence it spread rapidly throughout the eastern part of the United States. We have no record at the present time to indicate how long it has been present in this State. That it was found in certain greenhouses in Portland was called to our attention for the first time in the fall of 1913 by oral reports. No specimens were sent to this laboratory until the fall of 1914, when affected leaves were received from a greenhouse proprietor in Portland.

This rust causes small blisters, usually on the under surface of the leaf, though they may occur to a less extent on the upper surface. These blisters soon break open, exposing the dark brown powdery spores, as shown in Fig. 31. Chrysanthemum rust is known to exist in this country only in one spore stage (the II or uredinial).

Chrysanthemum growers should make every effort to secure cuttings from sections where this rust does not exist. It should be watched closely, and if any rust appears, the leaves should be removed and burned before any of the brown spore powder has an opportunity to scatter. Only strong stock should be used for propagating. If it is found that some varieties are more susceptible to the rust, as is often the case, then only the most hardy should be cultivated. In some sections it has been found to be more abundant where the plants are grown outside the greenhouse in the summer, and inside summer cultivation is preferable from the standpoint of the control of this disease. It is important that all unnecessary water be kept from the foliage in greenhouse-grown plants. Where these precautions are taken, the trouble should not develop into a serious pest.

Fig. 32. Cucumber stem showing surface growth of white mold of sclerotinia fungus.

CUCUMBER STEM ROT.

Sclerotinia libertiana Fuckel.

A disease of greenhouse cucumbers was sent to the laboratory of Plant Pathology in June, 1913, from Salem, Oregon, with the statement that three to four plants were wilting daily from this disease. An examination showed a fungus developing abundantly at or near the base of the plants. The fungus developed very rapidly and formed considerable external white mycelium (mold), as shown in Fig. 32, causing a rot of the stem resulting in a rapid wilt. Resting bodies of mycelium or sclerotia were found developing abundantly on the external mycelium.

The fungus was easily isolated in pure culture, and from the manner of attack on the plants and from the cultural characteristics, it would seem that this fungus is without doubt *Sclerotinia libertiana*, a common fungus causing a similar disease in a great many plants.

Later, Mr. F. D. Bailey, visiting this greenhouse, found considerable damage being done, and learned that a similar trouble existed on tomatoes and lettuce, not only in the greenhouse but in the adjoining garden.

Should this disease become prevalent, it would be necessary to change the soil frequently, being careful to obtain soil free from infection, preferably from a field that had not been used for vegetables for a number of years. It would also be important to avoid contaminating the compost heap with decaying vegetables or greenhouse plants, and to keep the greenhouse clean and well ventilated, avoiding over-watering.

EGGPLANT WILT.

Verticillium albo-atrum Reinke & Berth.

Fusarium sp.

A wilt disease of eggplant was first called to our attention in Oregon by Dr. H. W. Wollenweber, of the U. S. Department of Agriculture. He first noted this disease at Hood River, on the farm of Mr. Koberg, where the disease caused a loss of one-third of the plants in the field. It has also been reported from Medford and doubtless occurs in other parts of the State.[19] The mycelium of this fungus develops in the woody tissues of the stem and the fungus may be isolated from any part of the wood, including the petioles of the leaves, according to Dr. Wollenweber's statements.

This is a soil fungus and one which would be very difficult to control where it once obtained a foothold. No remedies have as yet been worked out. Rotation would be the logical thing to practice where this disease is abundant. Where irrigation was practiced it would be necessary, when selecting land on which susceptible vegetables were to be grown, to take into consideration the possibility of the disease being spread with the irrigation water.

A similar disease at Hermiston, Oregon, has since been noted by F. D. Bailey, but is found to be due to a Fusarium rather than to the above fungus. The general effect, however, is the same. These diseases are so similar that ordinary microscopic examination of the tissue is not a safe basis for determination, but isolation of the causal fungus should be made to decide definitely between the two diseases.

GOOSEBERRY DIE-BACK.

Botrytis sp.

A disease of gooseberries, characterized by a die-back, has been noticed for some time in Oregon. It was first sent to this laboratory from Lebanon and Hillsdale in the spring of 1912, and has since been received a number of times from various places. Mr. Ray Roberts, of Lebanon, has called our attention to the disease each spring for the past three years.

This disease may become evident as soon as the leaves come out in the spring, when it is observed that some branches are not putting out their leaves. The buds usually swell, but the leaves do not emerge. Sometimes the leaves may start, but will wilt before becoming fully formed. The branches are often killed back for a distance of 8 to 12 inches.

An examination of specimens received from Mr. Roberts in 1912 showed an abundant growth of gray mold which was found developing about the buds. This, on being carefully studied, proved to be a species of Botrytis. Cultures were carefully isolated by the writer from bark, wood, and pith by the tissue method, and in all cases mycelial growth developed, which, when transferred to the tubes of potato agar, showed an abundance of conidia and sclerotia.

In 1913, similar specimens were received, and Mr. F. D. Bailey made notes and conducted cultural studies. It was found on examination that on

[19]Orton, W. A. The Fungus Genus Verticillium in its relation to plant diseases (abstract) Phytopathology, 4:40, 1914.

nearly every twig near the junction of live and dead wood, longitudinal slits were present in the bark, from which tufts of the same Botrytis were abundantly developed. An examination showed that they were developed from sclerotia in the bark. The same Botrytis was found on the dead buds.

Cultures were made in the following manner: Melted agar was poured into each of six petri dishes and allowed to harden. Three of these plates were inoculated with bits of tissue carefully extracted from the inner bark of each of three diseased canes after carefully sterilizing the exterior. Three plates were inoculated by bits of discolored pith from each of the same canes. In five of the six plates, a sclerotia producing Botrytis was uniformly obtained. In the sixth plate, which was taken from badly discolored pith, a fungus other than Botrytis and bacterial contamination was obtained. An examination of this twig showed it to be in a very advanced stage of the disease.

No inoculation experiments were conducted at this time, as plants suitable for the purpose were not at hand. The Botrytis has been so constantly observed in association with the disease, and the cultural experiments give such uniform results, that the writer believes it highly probable that it is the cause of the die-back. The above-reported observations were made before any attempt was made to study the literature. A study of the literature made recently has revealed no record of the occurrence of a disease of this character in America, but a similar disease has been prevalent in England for a number of years and has been studied by Smith[20], Brooks and Bartlett[21], and Salmon[22].

A study of the work of these investigators shows that a disease resembling the trouble prevalent in Oregon, has been quite thoroughly studied, leaving little doubt but that Botrytis is the cause of the disease. A more careful study of our disease should be made before final conclusions are drawn, but it would seem highly probable that the trouble found in Oregon is identical with the European disease.

Until more is known relating to the disease, no final recommendations can be made in regard to control, but it is suggested that all diseased canes be immediately removed and burned and that care be taken not to break or wound the branches or buds any more than is necessary when picking or cultivating.

ONION SMUT.

Urocystis cepulae Frost.

The onion smut is, with the possible exception of the downy mildew or blight, the most serious of any of the diseases known to attack this crop in America. It is widely distributed, but until this season has not been recorded from Oregon.

It was first sent in by Mr. Andrew Kauffman, from Hubbard, in May, 1914, on seedling onions planted for sets. It has since been collected by Mr. F. D. Bailey, of this department, at Hubbard, Woodburn, and Fanno station (P. E. & E. R. R.) At Hubbard it was observed to occur on onion sets, while at the other places mentioned it occurred on young field onions. In a marsh near Woodburn a field was found in one part of which a large reduction in stand was evidently due to the smut.

Onion smut attacks the young seedlings and dark, opaque spots develop on the leaves. This condition is best seen by holding the leaves up to the light. The spots soon break open, exposing the powdery mass made up of the spores of the fungus that causes this disease. The leaves beyond the point of infection soon die. If seedlings are badly attacked, they may be entirely killed. Often they remain alive until harvest. In any case affected plants are considerably dwarfed as shown in Fig. 33 B and C. In many cases half-

[20]Smith, A. L. A disease of the gooseberry. Journ. Bot. 41. 1903.
[21]Brooks, F. T., and Bartlett, A. W. Two diseases of gooseberries. Ann. Myc. 8: 167-185. 1910
[22]Salmon, E. S. The Sclerotinia (*Botrytis*) disease of the gooseberry or die-back. Journ. South-east. Arg. Coll. Wye 18: 319, 1909. Journ. Bd. Agr. London 17:1-9, 1910.

Fig. 33. Onion smut. (A) Healthy plant for comparison with diseased plants B and C. (D Cross section of onion stem showing masses of smut spores.

grown onions may have the black spore masses developed in the scales of the bulb and leaves, appearing as black lines. (Fig. 33 D).

The spores fall to the ground from the leaves which are attacked and are capable of living over in the soil apparently for a number of years, affecting each subsequent crop of onions.

It is probable that onion smut is disseminated from one part of the country to another primarily through the spores being carried on the surface of the seed. Hence treatment of seed is the best method of preventing the introduction of this disease into a new district. After it becomes established, however, seed treatment is of no value and special methods are necessary if it is desired to continue onion culture on the land.

Recent experiments indicate that an application of a strong formalin solution in the drill rows at the time of seeding disinfects both seed and surrounding soil, and gives promise of being the most practical method of control yet devised. Further information will be given on application to the department of Plant Pathology.

ONION STEM ROT OR GRAY MOLD.

Botrytis sp.

A serious storage rot of onions was particularly abundant and attracted considerable attention among the growers during the spring of 1913. This

Fig. 34. Onion showing characteristic rot caused by gray mold. It is more common to find this condition starting at the stem end.

disease was first brought to our notice when specimens were received from Sherwood, Oregon in February, 1913, which showed advanced stages of the rot.

This disease is apparently the same as that discussed by Clinton[23] from Connecticut; it develops commonly at the stem end, though our observations show that the disease often attacks the onions at the base as shown in Fig. 34. The disease commonly spreads in the outer bulb scales, at first, rather than progressing through the center of the onion, and causes a soft rot, which finally involves the whole bulb.

Examination has shown a fungus (*Botrytis sp.*) constantly associated with the trouble which often develops abundantly on the surface or even between the bulb scales. The mold is usually developed very copiously and gives a grayish, brown color to the affected parts. Brown or black sclerotia are commonly developed in abundance, both on the surface and between the bulb scales. The fungus is easily isolated in pure culture and develops both spores and sclerotia in abundance.

This disease was most serious following the growing season of 1912. It seems probable that the peculiar weather conditions of that season go far to explain the outbreak of the trouble. The rainfall was quite excessive during the summer, and on this account the onion blight was not uncommon. This disease causes the death of the tops, and under our conditions this often takes place rather late after the onions are well formed, and causes in effect a premature ripening. Such onions do not mature well, since the central core does not ripen normally, and results in what are commonly called "bottle necks" by the growers.

Sometimes the onions have a tendency to start new growth after the tops have been killed down by blight, and if early fall rains prevail, this condition is likely to result in a soft stem end. The conditions as described above, coupled with early fall rains, which often interfere with the curing of the onions in the field, together with improperly ventilated store houses, will, we believe, account for the greater part of the loss occurring from this disease.

PEACH RUST.

Tranzschelia punctata (Pers.) Arth.

In October, 1913, Mr. C. M. Scherer, fellow in Botany in the department, in connection with studies on the California peach blight (*Coryneum beijerinckii*), collected peach leaves affected with a spot which at first was mistaken for the leaf spot due to the blight fungus.

These leaves showed the presence of small, irregular, purple spots about two to four mm. in diameter, often with small, lighter colored areas in the center. Older spots frequently become limited, and drop out, causing a shot-hole effect. The spot and holes are smaller, however, than those caused by Coryneum.

An examination revealed the fact that sori of a rust were present on the under surface of the spots. A microscopic study showed the spores to be urediniospores (summer or repeating spores) of *Tranzschelia punctata*, which is also common on prunes.[24]

The rust has for its alternate host, in the Eastern United States, *Anemone quinquefolia* and species of Hepatica. No collection of this stage has been found in the West so far as the writer is aware.

It is probable that this disease ordinarily does little damage, and will not as a rule necessitate the practice of any special control measures.

[23]Clinton, G. P. Report of the Station Botanist (Conn.) for the year 1903: 334–335, 1904. 1904: 321–322, 1905.

[24]Biennial Crop Pest and Horticultural Report, Ore. Exp. Sta. I: 1911-12. 259, 1913.

PEAR CANKER.

Monilia sp.

While making field investigations of the pear rust at Halsey, June 11, 1913, the writer found, on a pear tree of unknown variety, a canker commonly developed about the base of fruit spurs. The cankers were evidently recently formed in all cases observed and had not developed during the previous winter. The fruit spurs at the base of which the cankers were developed had started to produce blossoms and leaves but at the time of the examination the blossoms and leaves were dried up and covered with a moldy growth.

Where the fruit spurs were on small branches the cankers often developed sufficiently to girdle the twigs, and of course where this happened the twigs soon died and the foliage wilted and blackened. It appeared very much at a distance like twig blight caused by the fire blight organism. It was this condition which first attracted attention to the tree.

Specimens were taken to the laboratory and examinations made. The brown mold developed upon the shriveled blossoms was found to be a species of Monilia. Microscopic examination of the tissue of the bark of these cankers showed abundant mycelium of a fungus present. Tissue cultures from the bark were made by Mr. F. D. Bailey, with the result that Monilia was the only fungus uniformally obtained and this quite constantly in each of four plates.

The writer made a trip to Halsey again in October, 1913, and further observations were made. The cankers had not spread any since June and callus had developed, isolating the spots. Sporodochia of Monilia were found abundantly breaking through the outer bark of the cankers. These show plainly in the photographs (Figs. 35 and 36).

Fig. 35. Canker on pear branch caused by Monilia. Note the dried-up remains of the leaves and blossoms of the fruit spur.

Fig. 36. Similar canker girdling a young branch. Note pustules of Monilia in the dead bark.

A similar canker on pears was sent to this laboratory from Salem by Mr. E. C. Armstrong in May, 1914. Tissue cultures were made by Mr. G. B. Posey and a Monilia identical with the one discussed above was obtained. These cultures have been studied by Mr. Posey in comparison with the brown rot fungus which has passed as *Sclerotinia fructigena* (Pers.) Schroet. in this country, isolated from decaying fruit of apples, prunes and pears, and while final reports cannot be made at this time the evidence points strongly to the conclusion that this fungus under discussion is not the same. It has also been studied in comparative cultures with strains of *Monilia sp.* isolated from cherry, prune and apricot branches which it closely resembles.

This disease is being further investigated and is here recorded because we have failed to find any reference to such a disease of pear in American literature, and in the hope that interested growers will search for this canker in their orchard and if any cases are found that they will report and send specimens to this department for investigation.

It is worthy of note that Salmon[25] has described a similar canker on apples which he attributes to *Sclerotinia fructigena*. He states that the most common method of infection is by the mycelium growing from a diseased fruit into the bark when such fruit remains hanging on the trees and is in contact with the branch. Cankers may also be formed at the base of fruit spurs that have become diseased when the blossoms or fruit are attacked and the fungus passes from them through the fruit spur into the branch. There was no evidence obtained from our own observations to indicate that diseased fruit had any relation to the canker under discussion. No fruit rotted by Monilia has been found on the trees from which the canker has been collected. Dr. Jakob Eriksson[26] has also described a similar trouble occuring in Sweden on cherries and apples and refers to the occassional appearance of apparently the same disease on certain varieties of pear.

POWDERY MILDEW OF PEAS.

Erysiphe polygoni D. C.

The powdery mildew of field and garden peas has been sent in by correspondents or observed by members of the staff a number of times during the past few years. The fungus causing this disease forms a dense, and quite persistent, superficial growth of white mold (mycelium), which bears great quantities of summer spores from short branches of the external mycelial threads. The spores soon fall away and are produced in such abundance as to give a powdery appearance to the affected leaf. Later, black bodies appear, thickly scattered over the mycelium, which bear inclosed spores and constitute the winter or perfect stage of the fungus and serve to carry the fungus over the winter. (Fig 37).

This trouble is rarely of sufficient importance to warrant special treatment, though spraying with standard fungicides, especially those recommended for other powdery mildews would doubtless control the fungus. The fungus is known to hibernate in the seed and less trouble would be experienced if diseased plants were never used for seed purposes. In some sections of the country, notably in certain Atlantic and Southern states, this disease may cause considerable trouble. It is most common on late plantings, and it is stated that when young plants are attacked it may cause total loss.

It has been observed on several occasions in gardens where too much irrigation water has been used, and where overhead sprinkling was practiced. In such cases, greater care in the use of water would doubtless make conditions less favorable for the development of the disease.

[25]Salmon, E. S. A canker of apple trees caused by the brown rot fungus. Journ. Southeast Agr. College, Wye. 19:355. 1910. Gardener's Chronicle, May 21, 1910.

[26]Zur Kenntnis der durch Monilia-Pilze hervorgerufenen Blüten und Zweigdürre. Mycologisches Centralblatt. Bd. II, Heft 2, p. 65, 1913.

Fig. 37. Powdery mildew on peas. Note the white mold and the presence of minute black specks scattered over the mold. These are the fruiting bodies which bear the over-wintering spores.

DOWNY MILDEW OF PEAS.

Peronospora viciae (Berk.) De By.

A disease known as the downy mildew of peas has been observed in Oregon at Corvallis and Philomath, and doubtless occasionally develops in other sections as well. This disease causes gray-violet patches on the under surface of the leaves, often covering the entire area of the leaf as shown in Fig. 38. The violet tinge is due to the abundant presence of the spore-producing threads of the fungus which come to the surface of the leaf in such abundance as to form a mass of threads giving a downy appearance, hence the common name.

This fungus also attacks species of vetch, but has not become seriously abundant on either host. It is here mentioned as a disease that should be carefully watched. If the disease at any time should become serious enough to warrant special attention, it is probable that investigation would reveal a satisfactory method of prevention or control.

Fig. 38. Pea leaf attacked by downy mildew. Note the slight distortion of the leaflets and the moldy growth on the surface.

PEPPER LEAF SPOT AND BLIGHT.

Bacteriosis?

The occurrence of a pepper disease characterized by a leaf spot and blight of blossoms was observed at Gladstone, Oregon, on the farm of Mr. Hollowell, in September, 1912. The spots usually appear first on the under surface of the leaf as small, brownish spots less than one millimeter in diameter, with indefinite margins, irregular shape, and sunken slightly in the middle. As the spots enlarge, the shape often becomes more irregular, the center becomes more sunken, and the color in the middle changes to a pure white with occasionally a buff shade. Fig. 39 shows the general character of these spots.

Often before the spot reaches one millimeter in diameter, there appears a small irregular dark spot on the upper surface of the leaf. As the spots enlarge, the margins become more definite and distinct, appearing as an almost black, narrow border surrounding the white center of the spot, a mere line separating the white from the normal, green, healthy tissues of the leaf. Occasionally there is a smoky discoloration extending inward from the dark border toward the middle a short distance. Both sides of the leaf look alike in the older spots. Spots frequently coalesce, so that while single spots over five mm.

Fig. 39. Pepper leaf showing spots from which bacteria were isolated in pure culture.

in diameter are rarely noted, yet irregular aggregated spots may have a maximum diameter of about one centimeter.

In addition to the leaf spot, a blighted condition of the blossom clusters or of the individual blossoms was also noticed; though this was not studied in as much detail as the leaf spot, evidence suggests that it is probably due to the same cause.

A microscopic examination of the leaf spot revealed the presence of abundant bacteria. On this account dilution cultures were made from spots at different stages of development, independently by Mr. H. P. Barss and the writer, with absolutely uniform results. In all cases, abundant colonies of bacteria appeared in the dilution plates, with no evidence of contamination or mixed cultures. The colonies are convex, glistening, perfectly circular in outline,

even margined, and of a translucent, dirty white, with a tinge of buff. The size of the colonies did not reach over 3 mm. in diameter.

No pepper plants were available at this time for inoculation purposes, but seedlings were immediately started in the greenhouse, and in January Mr. F. D. Bailey conducted inoculation experiments with organisms isolated as mentioned above. One pepper plant and one tomato plant were inoculated by puncturing the stem in three places with a needle bearing the pure cultures of the bacteria. A check plant was also punctured. On February 6 these were examined, and small cankers were found to have resulted on the pepper plant with four leaves associated with these cankers found dead. The check plant showed no indication of the cankers. Spots on the leaves similar to those from which the cultures were isolated developed on the remaining healthy leaves of the inoculated plants. Isolations were made and bacteria resembling those originally used were obtained. Further inoculations did not develop uniform results, but the plants used were in poor condition.

In the summer of 1913, the field of Mr. Hollowell was again visited, but no disease was found. He stated that it started abundantly, but the plants were sprayed with Bordeaux mixture and no further occurrence of the disease was noted.

These results are inconclusive, but indicate strongly the possibility that this disease is of bacterial origin and is here included in the hope that if this disease occurs in any part of the state, growers will notify this department, so that further investigations may be made.

PRUNE BROWN ROT ON DRIED FRUIT.

Sclerotina fructigena (Pers.) Schroet.(?)

It has been a common belief among driers and packers that brown rot was likely to develop upon the fruit after drying, as a result, at least in part, of the failure of the drying process to kill the fungus in the tissues. During the prune-drying season of 1913, Mr. G. H. Godfrey, an assistant in this department, conducted a series of experiments under the direction of the writer to determine the extent to which the brown-rot organism is able to retain its vitality on prunes during the drying process. The work was carried on in connection with experiments on prune drying undertaken by the department of Horticulture.

The drier in which the tests were made was of the tunnel type with such arrangements as made possible the control and recording of the temperature in the tunnel. Badly brown-rotted prunes were selected. As a preliminary treatment, before being placed in the tunnel, some were washed merely in cold water, some in cold lye water, some in hot lye water, and some were steamed for half an hour. After this treatment the different lots, being placed in a tray, were run through the drier, and from each tray samples were removed at regular four-hour intervals until drying was completed. These samples were tested by cultures from the flesh in order to determine whether the brown rot had been killed or not. Nine different lots were sent through, each under different temperature conditions. In order to avoid atmospheric contamination of the specimens, the samples were removed from the driers with extreme care and placed at once in sterilized paper bags. The culture work was done as soon after removal from the tunnels as possible, and at a distance from the drier.

As a result of the tests it appears that the preliminary treatment had little or no effect upon the vitality of the fungus. In the tunnels the fungus was not killed in drying for 20 hours at the extremely low temperature of 100 to 110° F. It was killed out, however, within 20 hours at a temperature of 120 to 130° F. although not until the last quarter of that time. In no cases in which a higher temperature was used did any brown rot remain alive at the end of the drying, and in some cases it was apparently dead within four to eight hours.

In short, with the conditions under which the drying experiments of 1913 were conducted, the brown rot fungus was apparently killed where the drier reached or exceeded the temperature of 130° F. for any length of time.

It is not known what effect upon the fungus may result from the gradual concentration of the substance of the fruit nor what part the chemical changes going on in the prunes may take in the death of the organism. Temperature may not be the only factor responsible for the killing of the brown rot.

Attempts to grow the brown-rot fungus in the laboratory on dried prunes have not been successful. Our observations indicate that brown rot probably does not develop as a rot or mold on stored prunes. Samples of moldy prunes have been submitted to the department at various times and examination has shown the mold to be due to yeast or some other fungus, but not to brown rot. Further investigations are contemplated along this line and only an incomplete report is given here. We should be glad to receive from driers or packers at any time samples of prunes affected with mold.

Although brown rot does not apparently survive the drying process, this fact should not be taken as an excuse for the drying of rotted prunes. The fact that they were rotted before drying renders them unfit for use. The reputation of Oregon prunes will be at stake if the practice of drying rotted prunes is allowed to continue. If necessary, pure-food laws should be enacted to prevent this practice.

PRUNE SUNSCALD OR WINTER INJURY.

There has long been known in Western Oregon a disease of prune trees characterized by the dying of large areas of bark on the trunks of the trees, or in some cases by a complete girdling of the tree with its resulting death. The damage caused by this disease in many of the young prune orchards in the Willamette Valley is very serious. The name "Winter Injury" is often applied to this disease because of the fact that the injury seems to be done before the trees come out in the spring. Many growers, however, have applied the term "sun scald" to the disease because of the belief that the injury was confined largely, if not exclusively, to the south and southwest sides of the tree. It was the opinion that the injury appeared late in the winter or early in the spring whenever unusually warm, sunny days were followed by unusually cold nights. It was supposed that the side of the trunks exposed to the action of the sun during the warmest part of the day became heated up with a consequent expansion of the bark and increased activity of the tissues on that side. When a sudden cold snap then followed at night it was thought that the bark tissues thus subjected to a high temperature during the day, followed by a sudden extreme drop in temperature at night, were sometimes so severley affected that the death of greater or smaller areas resulted. The fact that some trees escaped while others received injury in the same orchard was attributed to differences in individual resistance.

In order to determine whether this explanation as to the cause of so-called "sunscald" was based upon actual facts, and if not, what were the real causes and what methods might control the trouble, an experiment was begun in 1911 in a young prune orchard near Salem by Mr. H. L. Rees, at that time assistant in the department of Botany and Plant Pathology.

In connection with this experiment, Mr. Rees visited a number of prune orchards in the Willamette Valley in which this disease was present. In about half of the cases recorded the affection was present on all sides of the trunk, no apparent connection between the direction of the sun and the position of the injury being found. In about the same number of cases, however, it was found that the majority of diseased areas were apparently confined mostly to the south and southwest side of the trunks. In almost all orchards, however, there was more or less injury found, also, on the north and east sides. These orchard inspections showed further that in general, old trees were very much less affected by the disease than the young trees. It also seemed not improbable that more than one cause might be responsible for the dying of the bark in different prune orchards.

In December, 1911, through the kindness of one of the prune growers near Salem, permission was obtained to use a young prune orchard with trees from one to four years old, and the experiment was begun. The so-called

Fig. 40. Photograph taken in prune orchard showing the method of shading the trunks in the experiment described in this article. This trunk shows a very severe canker.

"sunscald" injury was already quite abundant in this orchard, although a good many trees were still apparently healthy. The object of the experiment was to determine whether or not the shading of the trunks during the winter would decrease the number of new dead areas which would appear.

A certain number of apparently healthy trees were selected, one half of these shaded by setting a board upright in the soil on the southwest side of the trunk and at a little distance from the tree. The boards were, in general, slightly taller than the trunk. By this method of treatment the sun was prevented from striking the trunk during the hottest part of the day. The rest of the trees were left unshaded. A number of diseased trees were also shaded in the same way, and others left unshaded for checks. Some of these diseased trees were treated by cutting out the dead areas present and sterilizing the wound. A part of them were treated this way in December, 1911. The others were treated in April and May of the following spring. Records of the number of dead bark areas which made their appearance on the treated and untreated trees were taken from time to time, the final record being made in December, 1912, and January, 1913.

Table I is based upon figures taken by Mr. Rees at the time the final examination was made a year after the experiment was begun:

Table I. Effect of "Sunscald" on Shaded and Unshaded Trees.

		Total number of trees.	Showing new areas of dead bark on the south and west sides.		Showing new areas of dead bark on the north and east sides.		Showing new areas of dead bark adjoining cut-out spots.		Trees that died.		Showing no new areas of dead bark.	
Total number under observation		513	No.	%	No.	%	No.	%	No.	%	No.	%
Trees apparently healthy at the beginning	Shaded	145	17	11.7	10	6.89	....	....	5	3.4	118	81.3
	Unshaded	152	26	17.1	13	8.5	....	....	4	2.6	120	78.8
Trees with disease cut out in the fall	Shaded	36	14	38.8	17	47.2	19	52.7	5	13.8	1	2.7
	Unshaded	29	7	24.1	7	24.1	17	58.6	3	10.3	1	3.4
Trees with disease cut out in the spring	Shaded	71	19	26.7	24	33.8	18	25.3	3	4.2	19	26.7
	Unshaded	80	23	28.7	18	22.5	25	31.2	3	3.7	20	25.0
Totals	Shaded	252	50	19.8	51	20.2	37	14.6	13	5.1	138	54.7
	Unshaded	261	56	21.4	38	14.5	42	16.1	10	3.8	141	54.0

From the foregoing table it can be seen that the difference between the shaded and unshaded trees in the number of new cankers on dead areas formed on the trunks is very slight. Furthermore, the difference between the number of new dead areas of bark occurring on the south and west side as compared with those on the north and east side is not great enough to be really significant. The most that can be said is that there seems to be, in this particular case, a very slight tendency on the part of the unshaded trees to show a few more dead areas of bark on the south and west sides than on the north and east sides; but where the trunks were shaded practically no difference can be found in the number of new diseased spots on the two sides.

The results obtained from the experiment in this orchard indicate that at least some of those injuries which are classed as "sun scald" or "winter injury" in prunes have apparently little relation to the effect of sun during winter or spring. It should be borne in mind that these results were obtained from an experiment carried through only a single year, and in only a single orchard. Sweeping conclusions, therefore, as to what results might appear in other years or in other localities ought not to be made.

During the progress of the work noted in the foregoing paragraphs, Mr. Rees made further efforts to determine the cause of the injuries. Observations showed that they were frequently similar to the effects of the bacterial canker disease on cherries and the fact that large numbers of bacteria were sometimes found in the affected tissues led him to suspect that these organisms might be the cause of at least some of the trouble with which he was working. Bacteria were isolated from prune trees in four different cases in the spring of 1912. Upon inoculation into both prunes and cherries the same season, they proved to be pathogenic, although the resulting injury was not extensive. Mr. H. P. Barss later worked with the same strains and found them apparently identical with those causing bacterial canker of the cherry and equally virulent when inoculated with the cherry. In 1914 certain of these strains were again inoculated into prune and produced positive results. It would seem, then, that bacteria may produce cankers on prune trees. The reader is referred to a fuller discussion of the evidence in support of this statement to be found beginning on page 224 in the article on "Bacterial Gummosis of Cherry." It is not known, however, whether all the bark troubles common in this region on the prune are caused by the bacteria or not.

Mr. Rees also found fungi of various kinds in the dead areas of bark on the trunks of affected trees, many of which were isolated and tested by inoculations. In no case did any of them show any power to induce disease.

Sufficient work has not yet been done to make possible any definite recommendations concerning treatment, but the results which Mr. Rees obtained in working with this trouble in a single orchard led him to conclude that it was beneficial to cut out the dead areas, sterilize the wounds and cover at once with melted grafting wax. For this purpose he found black walnut grafting wax containing a double portion or more of tallow than usually recommended to be better than ordinary wax.

FIRE BLIGHT ON PRUNE.

Bacillus amylovorus Burrill.

On June 28, 1914, specimens of blighted prune twigs were received from Mr. L. A. Reineman, of Freewater, Oregon. These twigs had evidently died back suddenly while in a vigorous growing condition. The bark was blackened, the foliage dried up for at least ten inches back from the tip.

A careful microscopic study revealed an ambundance of bacteria in the tissues of the bark. These specimens were rather dry when received and an attempt to isolate bacteria gave negative results.

A similar disease was received July 29 from Mr. B. Baker, Freewater, and photographs were taken (fig. 41). Later the writer had occasion to visit this district and observe the trouble in the orchard. It was found not uncommon among Italian prunes, which were blighted back from the tips of

Fig. 41. Prune twig showing blight caused by the fire blight organism.

the twigs sometimes for ten or twelve inches, appearing very much like the fire blight of apple and pear, which is very common in near-by apple and pear trees, and was particularly serious in this district during the past season.

On account of this fact, the writer requested Mr. H. P. Barss to make isolations of cultures from the material sent in by Mr. Baker, with the result that cultures from four out of five twigs developed bacterial colonies. Three of the cultures studied were used to inoculate three green pears in the laboratory. The pears were previously washed in bichloride of mercury and kept in a covered glass dish. At the same time three pears were inoculated with three separate cultures of bacteria isolated from pear branches showing characteristics of fire blight. All the pears (except one inoculated with organism from prune) became rotted.

The infection resulting from inoculation with the prune organism in general developed a much more vigorous rot with abundant ooze, while that resulting from inoculation with the organism from pear produced much less vigorous rot and no ooze.

On July 7, Mr. J. H. Corsaut, fellow in Plant Pathology, inoculated three green prunes with the organism from prunes (B546), and three with fire blight from apple (B961), and four with the organisms used in the experiment from pear (B959). Those inoculated with the organism from prune twigs when examined after fifteen days all showed well-developed rotten areas over half their surface, and showed abundant development of ooze. The three prunes inoculated with fire blight from apple all developed similar characters. The four inoculated with the organism from pear showed different results, the infected areas becoming leathery and irregular. In only one case was ooze present, and then very sparingly.

On July 16, a pear tree was inoculated in the greenhouse at two points on the branches with the organism from prunes. One inoculation was made on a young, actively growing twig and one on an older twig. An examination ten days later showed infection at both points of inoculation, with abundant production of ooze. In one case the inoculation extended for ten inches both above and below the point of inoculation. The leaves were blighted and blackened. An examination two weeks later showed that the entire top of the tree had been killed. Another pear tree inoculated at about the same time gave similar results (Fig. 42).

On November 12 another inoculation was made in the greenhouse with the same culture, resulting in the development of a small canker which produced a small amount of ooze. This was removed and the organism re-isolated in cultures.

The organism has not yet been studied in comparative cultures with the fire-blight organism. The results obtained from these inoculations, however, indicate strongly that this blighting of prune twigs is due to the fire-blight organism, and, when compared with the results of Professor L. R. Jones[27], who demonstrated conclusively that a similar disease upon plums in Vermont

[27]Jones, L. R. Studies upon Fire Blight. Cent. f. Bakt. Abt. II. 9:835, 1902.

Fig. 42. Young pear trees showing tops killed by inoculation with organism isolated from prune twigs.

was caused by *Bacillus amylovorus*, we feel reasonably confident that such is the case.

SNAPDRAGON RUST.

Puccinia antirrhini Diet. & Holw.

A rust on the cultivated snapdragon (*Antirrhinum majus*) has been observed in a number of places in Oregon during the past few years and has caused serious injury to the infected plants. It was first called to our attention in 1910 by some specimens sent in from Portland by Mr. Charles Ladd. It has since been sent in from Salem, and has been collected at Corvallis both in gardens and in a greenhouse in 1911 and 1912. Furthermore, it has frequently been observed in various parts of Western Oregon.

This rust was first noticed in California by Mr. W. S. Blasdale[28], who stated it was so serious at Berkeley as to cause the death of the plants.

[28]Blasdale, W. S. A rust of the cultivated snapdragon. Journ. Myc. 9:81-83. 1903.

This disease attacks the stem, leaves, and often the seed pods, causing large brown spore pustules (sori), which break out from beneath the epidermis of the plant, exposing the brown spores (Fig. 43). The disease has only been

Fig. 43. Rust on stem and leaves of cultivated snapdragon.

collected here in the summer spore (uredinial) stage, although the winter spore stage (telial) is doubtless produced occasionally late in the season. Wherever this disease has been observed in out-door plantings, the plants were so seriously affected as to render them very unsightly before the blossoming period was over.

No experiments relating to the control of this trouble have been attempted, but it is believed that if proper care is taken to set out only perfectly healthy plants, and if proper precautions are taken to dig up and destroy any diseased plants that may appear, and never to use the same location for setting out the plants for more than one season, the disease should not prove to be continually destructive. It is possible that spraying with Bordeaux mixture or some other fungicide would control this trouble.

DOWNY MILDEW OF SPINACH.

Peronospora effusa (Grev.) Rbh.

This disease was found in a greenhouse near Eugene, Oregon, in considerable abundance on spinach, March 20, 1914. The disease causes a downy mold, which is usually gray or slightly violet in color, on the under surface of the leaf in spots. The abundance of the external reproductive threads of the mold gives the leaves the downy appearance. The upper surface usually shows the presence of pale yellowish spots, which in later stages of the disease turn brown.

This disease has been reported as doing serious damage in other states, particularly where spinach is grown as a commercial crop out-doors. Serious damage is not anticipated in Oregon. In the particular case mentioned above, it is probable that the disease was more prevalent on account of the fact that an overhead sprinkling system was used in the greenhouse, making conditions favorable for the development of the causal fungus. Should the disease become serious in greenhouses, it is probable that some other method of watering would have a tendency to reduce it.

DODDER ON TOMATO.

Cuscuta epithymum Murr.

A rather unusual disease of tomatoes was sent in by Mr. H. M. Marsh, of Looking Glass, Oregon, on July 13, 1914. The plants proved to be attacked by a species of dodder (Fig. 44). Examination showed it to be the same dodder which attacks alfalfa and clover in this state[29].

It is probable that infection of tomatoes is of rare occurrence and accidental. It is not to be looked upon as a trouble that is likely to become a pest, but is here included since no record of its occurrence on tomatoes has been found in a hasty review of the literature.

Fig. 44. A tomato plant attacked by dodder. The dodder was in blossom at the time the photograph was taken.

[29]Biennial Crop Pest and Horticultural Report, Oregon Exp. Sta. 1911-1912: 302. 1913.

INDEX

	Page
Acanthoscelides obtectus	130
Alder, tussock moth	179
Alfalfa, downy mildew	261
insects, clover and	95
looper as truck crop pest	184
rust	211
Allen, R. W	113
Amelanchier alnifolia rust	211
Anabrus simplex	134
Anarsia lineatella	113
Angumois grain moth	130
Antique or rusty tussock moth	173
Antirrhinum majus, rust	281
Anystis agilis Banks	107
Apanteles congregatus	171
Aphis, black cherry	200
cerasi	200
sorbi	181
wooly apple	95
Apple, aphis, wooly	95
and pear membracids, two	201
bud moth	103
feeding insect, a peculiar	200
fertilizer effect on fruit-pit	35
fire blight	261
fruit-pit	35
fruit tree leaf roller	109
fruit tree leaf syneta	101
leaf miner	119
membracids, two	201
natural hybrid, rust	211
pear leaf blister mite	124
rose-leaf hopper	189
rust	207
storage effect on fruit-pit	36
tussock moth	179
variegated cutworm	143
Apricot, bacterial canker	236
tussock moth	179
Archips argyrospila	109
Armillaria mellea	252
Arogallus lamberti	156
Aspen, tussock moth	179
Bacillus, amylovorus	261, 279
apiovorus	264
carotovorus	263
sp	263
Bacteria, in disease of filberts	213
Bacterial canker—apricot	236
cherry	224
peach	236
prune	235, 279
Prunus simonii	236
gummosis	224
Bacteriosis, pepper	274
Banks, N	181
Bean weevil	130
Beets, leaf spot of	262
Beech, tussock moth	179
Bemecia marginata	95
Bessey, E. A	159
Bibio nervosus	199
Bilberry, tussock moth on	179
Blackberry, rose curculio	150
rose-leaf hopper	190
Black cherry aphis	200
Blight, fire	261
pepper	274
Blister mite, pear leaf	123
Blossom fly	199
Bombyces	173
Bombyx	173
Borer, peach and prune twig	113
Botany and Plant Pathology, Report	203
Botrytis sp.—gooseberry die-back, cause of	266
onion rot	269
Bouquet, A. G. B	161
Bran mash, poison	134
Brown lacewing	181
Brown rot—experimental spraying	241
prune, on	276
Bruchophagus funebris	158
Bud click beetle	198
filbert mite	125
moth	102
weevils	197
Cabbage, variegated cutworm on	143
Cakili endetula	156
Calandra granaria	129
oryzae	130
Camnula pellucida	133
Canker—pear	271
Cathartus gemellatus	129
Celery—bacterial rot	264
heart rot	263
Cerasa basalis	201
Cercospora beticula	262
Cheese mite	130
Cherry—bacterial canker	224
bacterial gummosis	224
black aphis	200
bud moth	103
fruit tree leaf syneta	101
heart rot	234
pest, a new	121
rose-leaf hopper	192
tomato worms	170
tussock moth	179
wound parasites	234
Chrysanthemum rust	265
Cigarette beetle	130
Clark, W. T	113, 116
Clemens, Dr. B	120
Cleonus calandroides	150
canescens	156
punctiventris	155
quadrilineatus	156
sparsus	154
Click beetle, bud	198
Climbing cutworm	147
Clover and alfalfa insects	95
seed injured by midge	157
variegated cutworm	143
Colorado potato beetle	202
Cordley, A. B	117
Corylus sp., disease of	213
Crabapple—apple leaf miner	119
fruit tree leaf syneta	101
rust on	211
Crataegus douglasii, rust on	211
rose-leaf hopper	192
Ctenophora angustipennis	166
apicata	166
Cucumber beetles	95
stem rot	265
Curculio—rose	150
Curly dwarf of potato	255
Currant—fruit tree leaf syneta on	101
rose-leaf hopper on	192
Cuscuta epithymum	283
Cutworm—climbing	147
olive green	147
variegated	141
Cydonia japonica, rust on	211
Dargida procinctus	147
Dasyneura leguminicola	157
Department of—Botany and Plant Pathology, Report	203
Entomology, Report	95
Horticulture, Report	5
Dibrachys boucheanus	179

	Page
Diabrotica soror	201
Dieback—gooseberry	266
Diseases—potato	245–257
Dodder—tomato	283
Downy mildew—alfalfa	261
peas	273
spinach	282
Dry rot—potato	248
Drug store beetle	202
Early blight—potato	251
Eelworm, nematode or gallworm	159
Eggplant—tomato worms on	170
Elm—rose-leaf hopper on	192
Empoa rosae	95, 189
Entomology Department, Report	95
Eriophyes avellenae	125
pyri	123
tristratus erinea	125
vitis	124
Erysiphe polygoni on peas	272
Euphorocera claripennis	145
Evergreen blackberry—rose-leaf hopper	192
Ewing, H. E	107
Fertilizers—effect on fruit-pit	35
kinds and prices	11
recommendations for onions	20
result of field tests with onions	13
summaries of field tests with onions	13, 14, 17, 18, 20
tests on onion lands	7
Filbert—bud mite	125
new disease in Oregon	213
Fire blight—apple and pear	261
prune	279
Flour mite	130
Flowering crab, rust	211
Fruit-pit studies in Willamette Valley	35
Fruit-tree leaf roller	109
leaf syneta	96
Fusarium—coerulum on potato	248
orthoceras on potato	249
oxysporum on potato	245
sp. on egg plant	266
trichothecioides on potato	246
Gall mites, injurious	123
Gallworms, nematodes or eelworms	159
Garden slugs	95
Gooseberry—dieback	266
fruit-tree leaf syneta	101
Grain beetle, saw-toothed	129
moth, angumois	130
Granary weevil	129
Grape leaf mite	124
Grasshoppers in Oregon	133
Gray mold of onion	269
Greenhouse—nematodes	160
tomato investigations	25
variegated cutworm	141
Gummosis of cherry, bacterial	224
Gymnosporangium blasdaleanum—apple	207
cultivated mountain ash	211
flowering crab	211
hawthorn	211
hybrid mountain ash	211
incense cedar	211
Japanese quince	211
native crabapple	211
natural hybrid apple	211
pear	204
quince	207
service berry	211
witches' broom on cedar	211
Gypona octolineata	202
Hawthorn—apple leaf miner	119
fruit tree leaf syneta	101
pear leaf blister mite	132
rust	211
Hazelnut—fruit tree leaf syneta	101
tussock moth	179
Heart rot—celery	263
cherry	234
Heath—tussock moth	179
Hemerobius pacificus	181
Heterodera radicicola	159
Hops—variegated cutworm	141
Hopper-dozer	135
Hopper, rose leaf, as a fruit pest	189
Hornbeam—tussock moth on	179
Howard, L. O	95
Hylastinus obscurus	157
Hyslop, J. A	185
Incense cedar—rust on	206
witches' broom on	211
Indian meal moth	127
Injurious gall mites	123
Insect pests—clover and alfalfa	95
minor	195
stored products	127
Insecticide investigations	95
1914	137
Internal browning of potatoes	256
Irrigation—effect on pears	38
Japanese quince, rust on	211
Japanese rose—rose curculio	150
Jelly-end of potato	249
Lacewing, brown	181
Larch, tussock moth on	179
Laria pisorum	130
Lasioderma serricorne	130
Late blight of potato	257
Le Conte, Dr. J. L	100
Leaf hopper, rose	95, 189
Leaf miner, apple	119
roller, fruit tree	109
spot, beets	262
pepper	274
syneta	96
Leptinotarsa decemlineata	202
Libocedrus decurrens, rust on	206
witches' broom on	211
Limonius discoideus	198
Lithocolletis crataegella	119
Loganberry, large leaf hopper of	202
root borer	95
Looper, alfalfa as a truck crop pest	184
Malus floribundus, rust on	211
rivularis, rust on	211
Mash, poison bran	145
Meal moth, Indian	127
Melander, A. L	95, 171
MacGillivray, A. D	95, 121
Melanoplus, atlantus	133
femur-rubrum	133
Membracids, two apple and pear	201
Midge, clover seed injured by	157
Minor insect pests	195
Mite, cheese	130
flour	130
injurious gall	123
filbert bud	125
grape leaf	124
pear leaf blister	123
walnut leaf	125
Moisture supply, effect on pears	38
Monilia sp	271
Mountain ash, cultivated, a rust on	211
hybrid, a rust on	211
tussock moth	179
Mushroom root-rot, potato	252
Myzus ribis	181
Nematode, control	161
gallworms or ellworms	159

	Page
New cherry pest	121
Non-parasitic diseases of potato	255
Notolophus, antiqua	173
Nursery stock, black cherry aphis on	200
Oak, rose-leaf hopper on	192
tussock moth	179
Olive green cutworm	147
Onion, beaverdam soils	8
fertilizer recommendations	20
fertilizer tests on	7
field practices	12
gray mold	269
prices	12
results of fertilizer field tests	13
smut	267
stem rot	269
storage rot	269
summaries of fertilizer field tests	13, 14, 17, 18, 20
Orgyia nova	173
Paraptochus sellatus	197
Pea, downy mildew	273
powdery mildew	272
weevil	130
Peach and prune twig borer	113
Peach, bacterial canker	236
fruit tree leaf syneta	101
rust	270
spotted diabrotica	201
Pear, affected by moisture supply	38
bud moth	103
canker	271
fire blight	261
fruit tree leaf syneta	101
rust	204
two membracids	201
leaf blister mite	123
Peculiar apple-feeding insect	200
Pepper, bacteriosis	274
blight	274
leaf spot	274
Peridroma margaritosa saucia	141
Peronospora effusa	282
trifoliorum	261
viciae	273
Phalaena	173
Phlegethontius quinquemaculata	170
sexta	170
Phorbia brassicae	154
Phorocera saundersii	145
Phorodon humuli	181
Phyllonorycter (Lithocolletis) crataegella	119
Pimpla inquisitor	179
Pine, tussock moth on	179
Plagia americana	185
Plant diseases, notes	261–284
Plodia interpunctella	127
Plum, fruit tree leaf syneta	101
tussock moth	179
Plusia californica	184
Poison bran mash	134–145
vegetable bait	146
Pollination, tomato—blossom records	27
methods of	25
recommendations	34
value of	28
Poplar, tomato worms on	170
Potato, Colorado potato beetle	202
curly dwarf	255
disease notes	245–257
dry rot	248
early blight	251
fusarium wilt	245
internal browning of tubers	256
jelly-end	249
late blight	257
mushroom root rot	252
nematodes	160
non-parasitic diseases	255
powdery dry rot	246
Rhozoctonia violacea	252
silver scurf	250
spraying experiments	257
storage rot	245
tomato worms	170
variegated cutworm	143
Verticillium wilt	252
Powdery dry rot of potato	246
mildew of peas	272
Prionus, beetle	195
californicus	195
Protective cylinders	146
Prune, *Bacillus amylovorus*	279
bacterial canker	235–279
brown rot	276
bud moth	103
fire blight	279
fruit tree leaf syneta	101
Indian meal moth	127
rose-leaf hopper	192
rot on dried fruit	276
shading experiment	277
spraying to control brown rot	241
sun scald	277
tipulid work in wood	166
twig borer, peach and	113
winter injury	277
Prunus simonii, bacterial canker	236
Puccinia antirrhini	281
chrysanthemi	265
Quince, fruit tree leaf syneta on	101
pear leaf blister mite	124
rust	207
tussock moth	179
Radish weevil, a new pest	154
Raspberry, Rose curculio on	150
rose-leaf hopper	192
tussock moth	179
Report of—	
Department of Botany and Plant Pathology	203
Department of Entomology	95
Department of Horticulture	5
Rhizoctonia violacea	252
Rhynchites bicolor	150
Rice weevil	130
Root borer, loganberry	95
Root weevil, strawberry	95
Rose, curculio, injures blackberry buds	150
leaf hopper	95, 189
tussock moth	179
Russian thistle, butterfly	131
Rust, apple	207
chrysanthemum	265
flowering crab	211
Gymnosporangium blasdaleanum	204
Hawthorn	211
incense cedar	206
Japanese quince	207
mountain ash	211
native crabapple	211
natural hybrid apple	211
peach	270
pear	204
quince	207
rusty tussock moth	173
service berry	211
snapdragon	281
Sage—variegated cutworm on	142
Sarcophaga kellyi	136
Saw-toothed grain beetle	129
Sciopthes obscurus	197
Sclerotinia fructigena	272, 276
libertiana	265
Service berry—rust	211

Page

Shading experiments—prune ... 277
Silvanus surinamensis ... 127
Silver scurf—potato ... 250
Simplemphytus pacificus ... 121
Sitodrepa panicea ... 202
Sitotraga cerealella ... 130
Smith, H. S. ... 95
Smut—onion ... 267
Snapdragon—rust ... 281
Snout beetles ... 154
Soils—selection for field tests of onions ... 8
Solanaceae—tomato worms on ... 170
Sorbus sambucifolia, rust on ... 211
  spuria, rust on ... 211
Species of *Cleonus* ... 156
Spinach—downy mildew ... 282
Spondylocladium atrovirens ... 250
Spotted Diabrotica as fruit pest ... 201
Spraying—potatoes ... 257
  brown rot of prunes ... 241
Square-necked grain beetle ... 129
Steiroxys borealis ... 135
Stem rot—cucumber ... 265
  onion ... 269
Stictocephala inermis ... 201
Storage—effect on fruit-pit ... 36
  rot of onions ... 269
  rot of potatoes ... 245
Stored products, insect pests of ... 127
Strawberry—recommendations for planting ... 93
  relative importance in Oregon ... 50
  root weevils ... 95
  rose-leaf hopper ... 189
  variegated cutworm ... 143
  varieties in Oregon ... 50–94
  Abington ... 54
  Albany ... 54
  American ... 54
  Anna ... 54
  Arizona Everbearing ... 54
  Aroma ... 54
  Armstrong ... 55
  Atlantic ... 55
  Auto ... 55
  Autumn ... 55
  Autumn Belle ... 56
  Banquet ... 56
  Barrymore ... 56
  Beaver ... 56
  Bederwood ... 57
  Beidler ... 57
  Belle ... 57
  Belt ... 57
  Berlin ... 58
  Big Bob ... 58
  Bismark ... 58
  Black Beauty ... 58
  Blizzard Belt ... 58
  Bomba ... 59
  Bountiful ... 59
  Brandywine ... 59
  Brunette ... 59
  Bubach ... 59
  Burt ... 56
  Buster ... 60
  Cameron ... 60
  Captain Jack ... 60
  Cardinal ... 60
  Challenge ... 61
  Chellie ... 61
  Chesapeake ... 61
  Chipman ... 61
  Clara ... 61
  Clark ... 61
  Climax ... 62
  Cloud ... 62
  Clyde ... 62
  Columbia ... 63
  Commander ... 63
  Commonwealth ... 63

Page

  Cooper ... 63
  Corsican ... 63
  Crescent ... 64
  Crimson Cluster ... 64
  Dicky ... 64
  Dornan ... 64
  Dunlap ... 65
  Dutter ... 65
  Earliest ... 65
  Early Beauty ... 66
  Early Bird ... 66
  Early Hathaway ... 66
  Eleanor ... 66
  Elma ... 66
  Enormous ... 67
  Ettersburg No. 71 ... 67
  Ettersburg No. 75 ... 67
  Ettersburg No. 80 ... 67
  Ettersburg No. 89 ... 67
  Ettersburg No. 94 ... 68
  Ettersburg No. 121 ... 68
  Excelsior ... 68
  Fairfield ... 68
  Fendall ... 69
  Florella ... 69
  Fremont Williams ... 69
  Gandy ... 69
  Gill ... 70
  Gladstone ... 70
  Glendale ... 70
  Glen Mary ... 70
  Gold Dollar ... 70
  Golden Gate ... 71
  Goodell ... 71
  Good Luck ... 71
  Granville ... 71
  Great Scott ... 71
  Hampden ... 72
  Hartnell ... 72
  Haverland ... 72
  Henderson ... 72
  Highland ... 72
  Hopkins Choice ... 72
  Hovey ... 73
  Howard ... 73
  Hummer ... 73
  Ideal ... 73
  James Todd ... 73
  Jessie ... 74
  Jim Dumas ... 74
  Johnson ... 74
  Jucunda ... 74
  Kansas ... 74
  Klondike ... 75
  Louise ... 75
  Lovett ... 75
  Luther ... 75
  Magoon ... 75
  Malinda ... 76
  Mammoth Beauty ... 76
  Marie ... 76
  Mark Hanna ... 77
  Marshall ... 77
  Mary ... 77
  May King ... 77
  Mead ... 77
  Mellie ... 78
  Michel ... 78
  Michigan ... 78
  Midnight ... 78
  Miller ... 78
  Missionary ... 79
  Monmouth ... 79
  Multnomah ... 79
  New Acme ... 79
  New York ... 79
  Nick Ohmer ... 80
  North Shore ... 80
  Norwood ... 80
  Oaks Early ... 80

	Page
Ohio	80
Ontario	80
Oom Paul	80
Oregon	81
Oregon Everbearing	81
Oregon Ironclad	82
Oswego	82
Paris	82
Palmer Early	82
Parker Earle	82
Parson	83
Paul Jones	83
Peabody	83
Pearl	83
Pineapple	83
Pineapple Flavored	83
Pioneer	84
Poco Moke	84
President Roosevelt	84
Quality	84
Red Bird	84
Reliance	84
R. H. Smith	85
Richmond	85
Ridgway	85
Rockhill Seedlings, Nos. 1-12	85
Rough Rider	85
Ruby	86
Sample	86
Saratoga	86
Seaford	86
Senator	87
Sharpless	87
Sixteen to One	87
Splendid	87
Stevens	88
Success	88
Summit	88
Sunshine	88
St. Louis	88
Tennessee	89
Texas	89
Third Class	89
Thompson	89
Thompson No. 2	89
Three W.'s	90
Triomphe de Gand	90
Van Deman	90
Vick	90
Vick's Uncle Joe	90
Virginia	90
Warfield	90
Wilson	91
Wolverton	91
World's Wonder	91
Sturmia inquinata	171
Sunscald—prune	277
Sweet corn—variegated cutworm	143
Syneta albida	96
fruit tree leaf	96
Telenomus orgyiae	179
Tetranychus telarius	181
Thistle butterfly	131
Thricolepis inornata	197
Tipulid work in prune wood	166
Tmetocera ocellana	102
Tobacco—tomato worms on	170
Tomato—blossom records	27, 30
dodder	283
forcing	26
greenhouse investigations	25
nematodes	161
pollination methods	28
pollination recommendations	31
summary	31
variegated cutworm	143
varieties	27-34
worms	170
yields	27
Tranzschelia punctata	270
Trap lights	146
Trimerotropis vinculata	134
Trombidium locustarum	136
Tussock moth—antique or rusty	173
food plants	179
Twig borer, peach and prune	113
Two apple and pear membracids	201
Tyroglyphus farinae	130
lintneri	130
Urocystis cepulae	267
Van Dyke, E. C	95
Van Duzee, E. P	95
Vanessa cardui	131
Variegated cutworm	141
Vegetable—poison bait	146
soft rot	263
Verticillium albo-atrum—eggplant	266
potato	252
Verticillium wilt—potato	252
Vierick, H. L	95
Walnut—Indian meal moth	127
leaf mite	125
Weevil—bean	130
bud	197
pea	130
radish	154
Weldon, G. P	113
Wheat—drug store beetle in	202
Wild crabapple—apple leaf miner	119
fruit tree leaf syneta	101
Wild rose—rose curculio	150
Willow—fruit tree leaf syneta	101
tussock moth	179
Wilt—eggplant	266
Winter injury—prune	277
Woolly apple aphis	95
Worms, tomato	170
Wound parasites on cherry	234